SCIENCE

5 February 1960

Vol. 131, No. 3397

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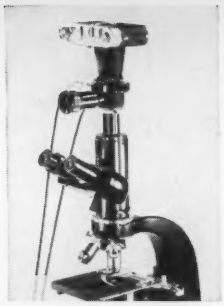

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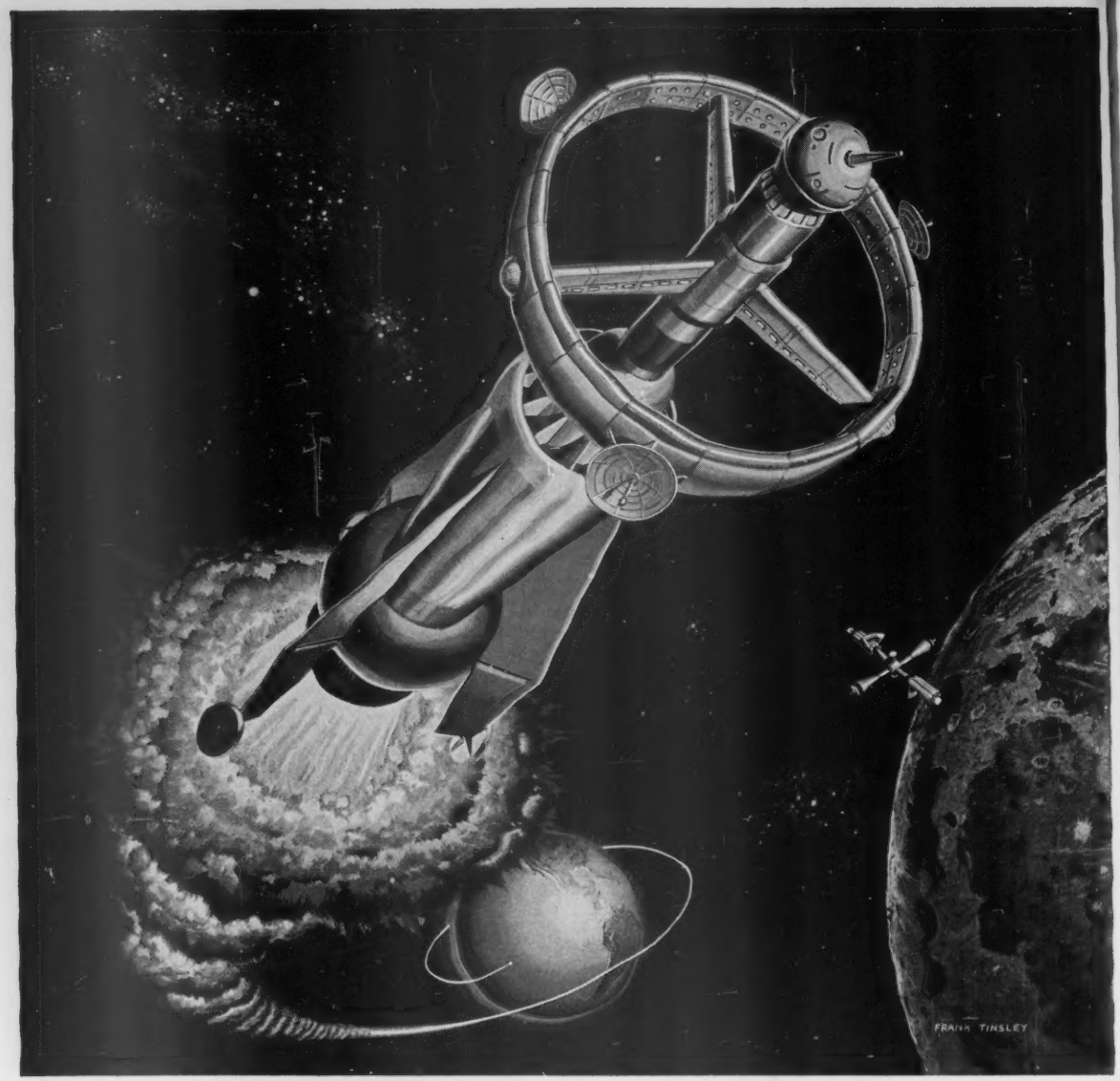

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5 February 1960, Volume 131, Number 3397

SCIENCE

Cover

Kilauea Iki Volcano, Hawaii, 5 December 1959. The vent is about ¾ mile away from the camera. The lava lake, which is 1 mile long, is about 300 feet below. Violent fountaining of lava is apparent as the liquid is hurled into the air, giving a reddish glow to the surrounding area. Wave action on the lava lake is shown by the lines in the foreground which represent glowing lava showing through breaks in the lava crust. The photograph was taken at approximately 4:00 A.M. [Courtesy E. J. Britten]

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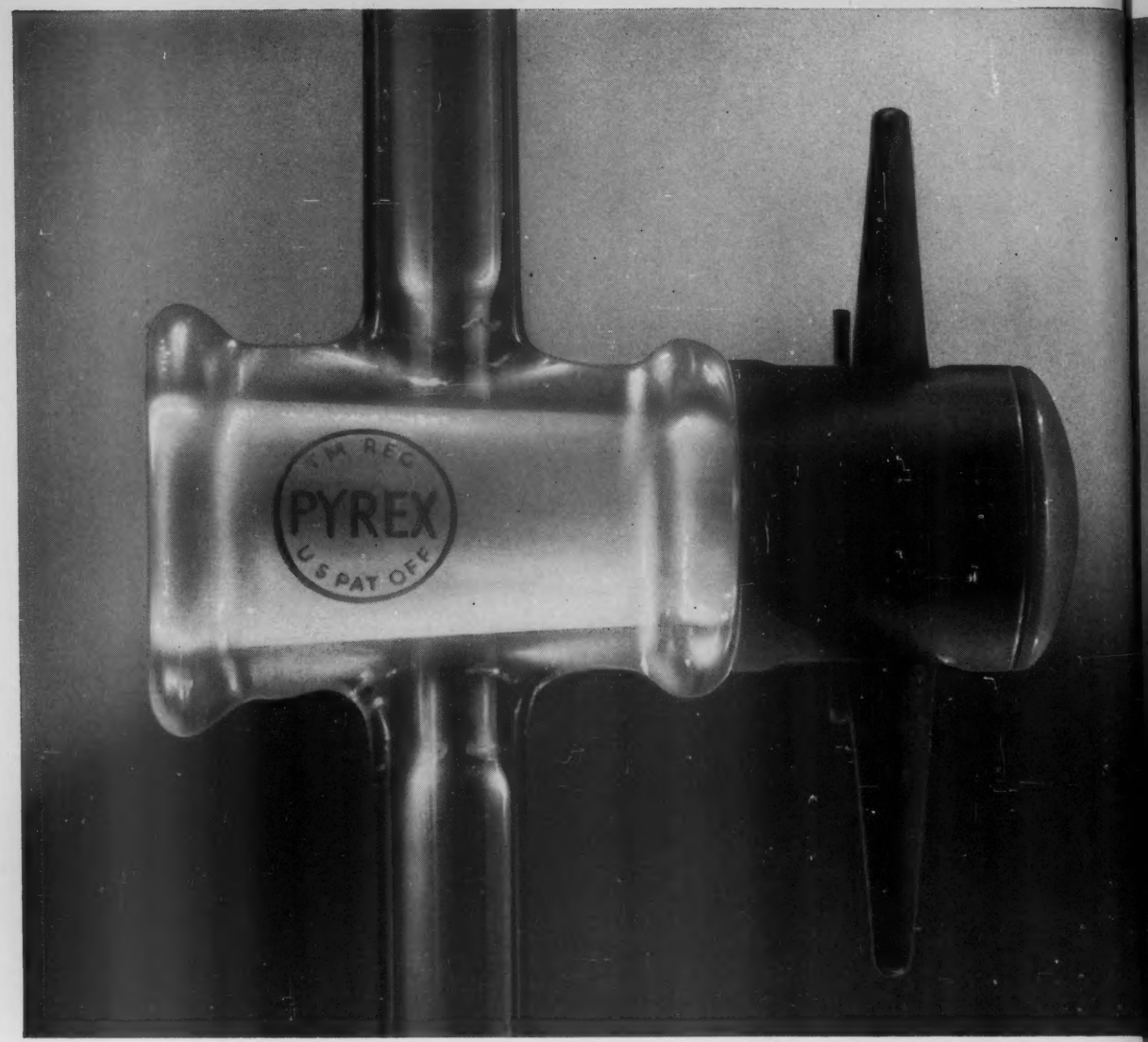

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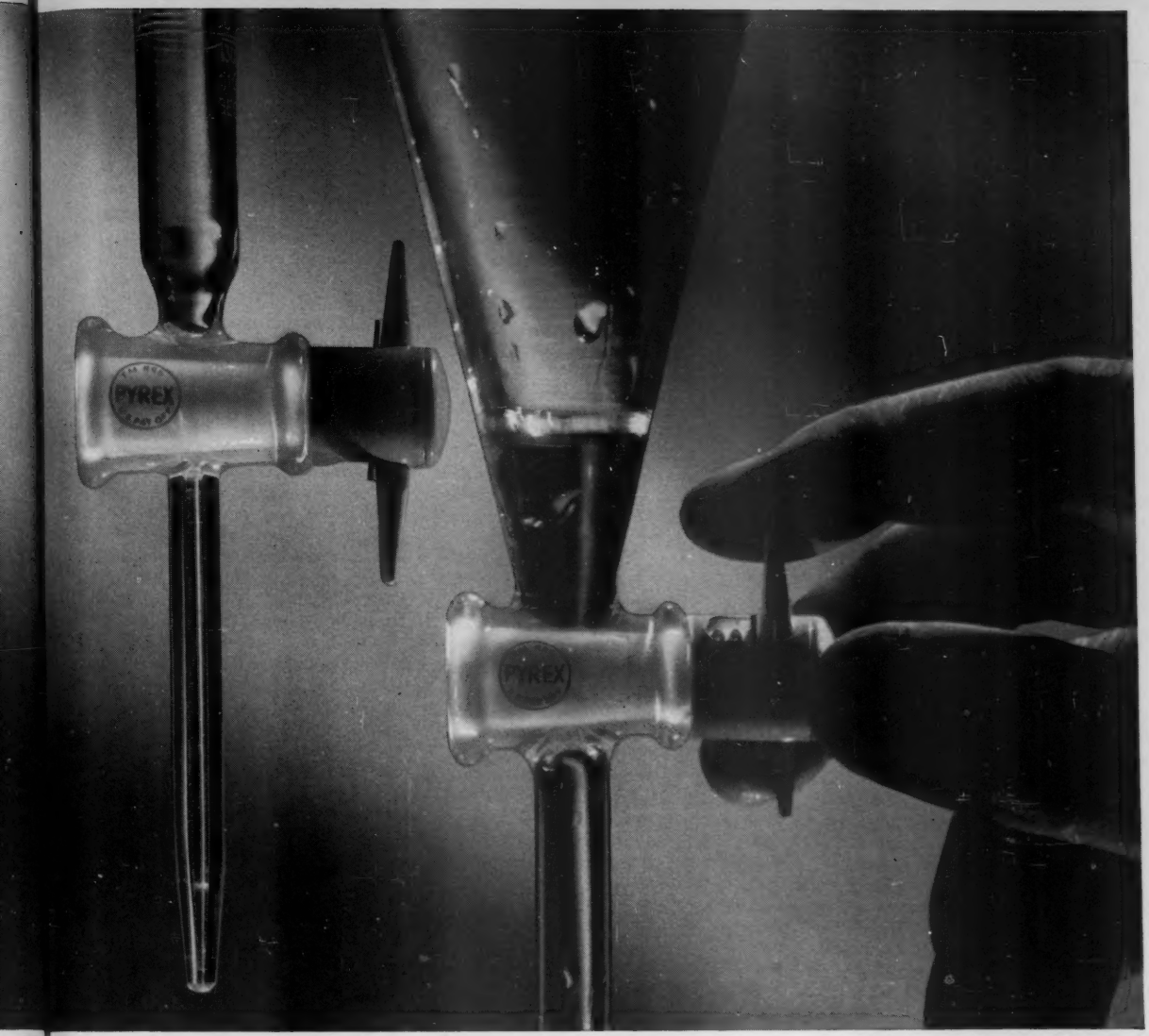

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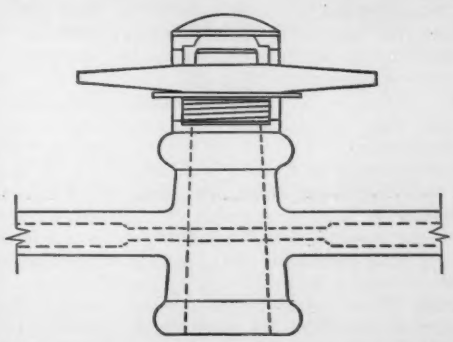

REVERSE-TAPER design makes for automatic self-adjustment on this new PYREX brand Teflon stopcock.

Letters

Russian Transliteration

The two articles in *Science* [**129**, 1111 (1959); **130**, 482 (1959)] about Russian transliteration end with a correctly stated but, for scientists, somewhat disappointing view—"that a universally accepted solution is not yet at hand."

Razran rendered a service in bringing up this problem in *Science*. Unfortunately his "new system" adds to the prevailing confusion since he neglects fundamental aspects in compromising between transliteration and transcription. The inadequacy of his "complete and uniform transliteration of Russian" was widely demonstrated and justly criticized in *Science* from four different sides. After studying the critics' comments and Razran's reply, we have to realize that our objective in transliteration is to reproduce a Cyrillic script with letters of the Latin alphabet. Transliteration must be unambiguous, accurately reconvertible, workable, and as simple as possible. It must be admitted that none of our present systems of transliteration meets these requirements. While Fabergé, and London and London advocate in *Science* that the system of transliteration of the Library of Congress be maintained with very minor changes, Hamp and Ray have suggested more decisive alterations to improve the same system. These suggestions should be given due consideration because an improvement is mandatory, and it is advantageous to modify a prevailing system instead of devising an essentially new one.

It is, of course, very important that only one system be adopted, although this is beyond our control. Also, the new system should be acceptable to people in Western Europe (the French, the Germans, the Italians) who use the Latin alphabet, and even to Russians, who frequently transliterate names. If by "transliteration" is meant a system to indicate the pronunciation of Russian words, naturally separate systems would have to be adopted for French-, German-, Italian-, and English-speaking people. This would certainly be disadvantageous.

Transliteration of Russian is a necessity. It is feasible to attain one system acceptable at least to scientists if our aim is not utopistic. I feel that *Science*, by publishing discussions on the subject, could contribute much to solving this problem without "tinkering forever with Russian transliteration." I agree gladly with Razran, that a "greater and speedier effort to achieve unity is needed," but our goal and our methods must remain realistic.

I am grateful to all those who have demonstrated correctly our inadequacies and our requirements. As one who is neither a native nor a linguist but who must, however, frequently use transliteration, I would appreciate learning of any further development for improving our present practices. In my opinion we Americans, leaders in many fields, have the moral responsibility for developing an improved transliteration of Russian.

GEORGE SUSICH
Pioneering Research Division, Quartermaster Research and Engineering Center, Natick, Massachusetts

As was stated in the two articles under discussion, the system of Russian-English transliteration which I proposed differs only slightly from that used by the Joint Slavic Committee of the American Council of Learned Societies and the Social Science Research Council in the *Current Digest of the Soviet Press*, on the one hand, and from the system of the Consultants Bureau and of the Pergamon Institute in their numerous translations of Russian scientific periodicals and monographs, on the other. It is thus difficult to see how what is in essence an attempt to bring together two close and widely used and authoritative systems is a "new system" that "adds to the prevailing confusion." Moreover, in view of Susich's concern for adoption of a system that the Russians may also use, I should like to say that I have recently checked a wide variety of Russian-English translations done in the Soviet Union and find their system of transliteration to be even closer to what I propose: *Belsky* instead of *Belskii* or *Belskyy*, *Vorobyov* instead of *Vorobëv*, and even *Khrushchov* instead of *Khrushchev*. Or, in other words, the transliteration systems of the three main agencies directly involved in Russian-English translations and abstractions—the Consultants Bureau and the Pergamon Institute in the physical and biological sciences (Consultants gave up the system of the Library of Congress in January 1959), the Joint Slavic Committee in the human and social sciences, and the Russians themselves—are now quite close to each other, with only very small differences, which most probably could be ironed out through a conference (I would prefer an experiment but would settle for a conference). The criticisms of my transliteration proposals which Susich considers just, and which I consider mostly irrelevant, apply to the three systems no less than to my proposals.

The basic considerations of the pragmatics of Russian-English transliteration should really not be difficult to comprehend. They revolve, first, around the realization that language is spoken even when it is read and that the current accelerated increase in the number of Russian names and terms in American [English] science and letters necessitates communicative-auditory discussions in the classroom, laboratory, conference room, and elsewhere; that is, the transliteration needs to provide in some way for constant approximation in pronunciation. Of all the critics, Hamp seems to be the only one to recognize this need. Second, there is the consideration that Russian, unlike English, is primarily a "phonetic" language, so that with only some effort the need to approximate pronunciations can be met through graphic transliteration, and that while it is true that the graphic desiderata become thereby somewhat forced and complicated, the outcome is nevertheless preferable to having two separate systems, one for graphic purposes and one for purposes of approximative pronunciation. The fact that the Consultants-Pergamon pure graphic transliterations differ but little from the Joint Slavic Committee transliterations, whose stated aim "is to approximate Russian sounds," is obvious objective evidence for the position taken. Susich "agrees gladly" with me that "a greater and speedier effort to achieve unity [uniformity] is needed" but says that "our goal and methods must remain realistic." He, however, is not realistic when he thinks of what should be done without considering or realizing what could be done; it is not just a matter of fiat.

GREGORY RAZRAN
Queens College, Flushing, New York

Tax Deduction for Charity

The tax-deduction stand of William J. Martin [*Science* **130**, 1435 (1959)] seems open to attack. The 10-percent deduction is set up on the assumption that a certain percentage of one's income is given to charity. If one contributes this amount or *less*, it is profitable to use the standard deduction. The person who does this is given his 20-cent tax rebate for contributing an amount to charity all or part of which he may have just pocketed, tax free; the less he gives, the more he gains. The dollars that Martin gives away below the amount allowed by the standard deduction are *less*-than-80-cent dollars and become 100-cent dollars only when he gives away more than his standard deduction will cover; in this case, elementary economics suggests that he make out a long form.

CANDIDA F. FRENKING
Textile Research Journal, Princeton, New Jersey

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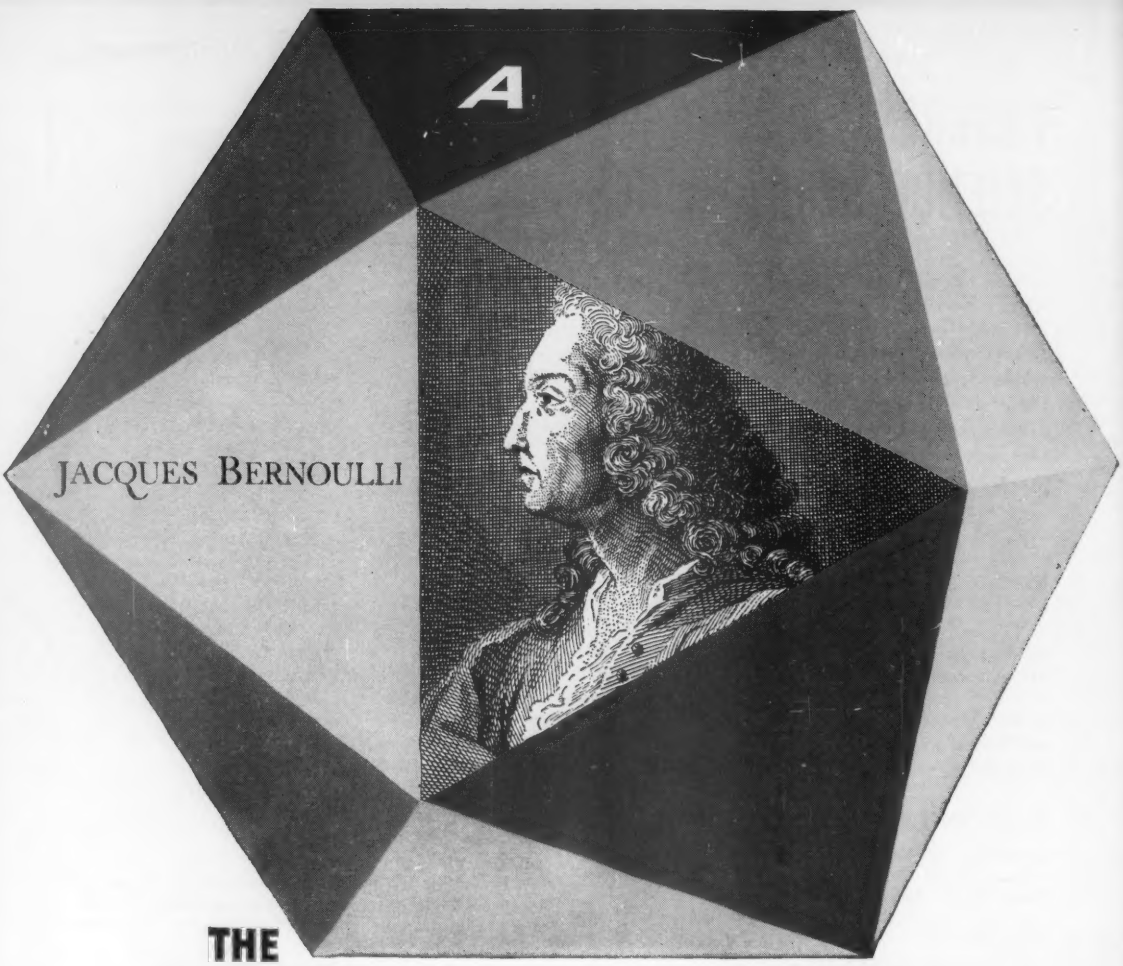

THE WIZARD OF ODDS

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Jacques Bernoulli, the great Swiss mathematician, pondered a question early in the 18th century. Can you mathematically predict what will happen when events of chance take place, as in throwing dice?

His answer was the classical Bernoulli binomial distribution—a basic formula in the mathematics of probability (published in 1713). The laws of probability say, for instance, that if you roll 150 icosahedrons (the 20-faced solid shown above), 15 or more of them will come to rest with side "A" on top only about once in a hundred times.

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Telephone engineers discovered at the turn of the century that telephone users obey Bernoulli's formula. At Bell Telephone Laboratories, mathematicians have developed the mathematics of probability into a tool of tremendous economic value. All over the Bell System, the mathematical approach helps provide the world's finest telephone service using the least possible equipment. The achievements of these mathematicians again illustrate how Bell Laboratories works to improve your telephone service.

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5 February 1960, Volume 131, Number 3397

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Military, Space, and Other Research, 1961

If Congress approves the President's budget—which it never does without some change—research and development funds of the federal government will total $8.391 billion for the fiscal year 1961, a sum 6 percent above 1960 and 25 percent above 1959. Eighty-three percent of the total is intended primarily for national security needs, 70 percent for the Department of Defense and 13 percent for the Atomic Energy Commission. The other 17 percent is budgeted for nonmilitary purposes.

Individual agencies will fare quite differently in the over-all increase. In percentage terms, the Bureau of Reclamation will experience the largest jump, from $269,000 to $1,484,000. The Coast and Geodetic Survey and the Office of Saline Water will have approximately twice their 1960 amounts. Among the larger agencies, NASA will have the biggest increase, from $325 to $600 million. The President has asked Congress to increase Public Health Service research funds from $305 to $350 million, and National Science Foundation research funds from $71 to $101 million. (The latter two agencies will have other funds for fellowships and other aids to science education.) Other agencies will remain at about their 1960 levels or will have more modest increases. In size, they vary from the Department of Defense, which is slated to have a miniscule $2 million reduction in a budget totaling close to $6 billion, to the Bureau of Public Assistance, for which the President has requested a $1000 increase over its 1960 research budget of $122,000.

The budget includes $600 million for basic research ($100 million above 1960) and $515 million for research and development facilities ($55 million above 1960). The great bulk of the facilities funds will go to the Atomic Energy Commission, the Department of Defense, and the National Aeronautics and Space Administration, but three smaller amounts, for constructing or improving research facilities, are of particular interest: $36 million for the Public Health Service, $22 million for the National Science Foundation, and $11 million for the National Bureau of Standards.

Also in the budget, but not in the research and development category, are funds for fellowships, training grants, and a variety of other aids to science teaching and science education: $90 million for the National Institutes of Health, $69 million for the National Science Foundation, and $64 million for the U.S. Office of Education. This latter figure includes aid to other fields of education.

If there is a pattern in these figures, the clearest factor is the continuation of an upward trend. Not since 1948 has the amount been smaller than it was the year before. The 1961 total is over 100 times the 1940 figure. A second factor is the greater relative growth of the nondefense segment. In the national security area (Department of Defense and Atomic Energy Commission) the 1961 total is 2 percent above 1960 and 16 percent above 1959. For all the rest of the agencies, the 1961 total is 38 percent above 1960 and 94 percent above 1959. But much of this increase is for the rapidly growing National Aeronautics and Space Administration. Its budgets for 1959, 1960, and 1961 account for 19, 31, and 42 percent, respectively, of nondefense research and development figures. To a conservative, geo-centered observer it seems good that we are still devoting more than half of this total to research on earthly problems. But 1961 may be the last such year; the trend suggests that 1962 will see the fiscal center of gravity of our nondefense R & D expenditures somewhere out in space.—D.W.

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Radar Echoes from the Sun

Man's first direct contact with the sun opens new approaches for the study of solar events.

V. R. Eshleman, R. C. Barthle, P. B. Gallagher

On a number of mornings in September 1958, April 1959, and September 1959, attempts were made at Stanford University to obtain radar echoes from the sun. The data obtained on three days in April have been intensively analyzed with the aid of a digital electronic computer. It appears that solar echoes were obtained on each of these days. This experiment was possible only because of the availability of facilities built up at Stanford for several different research programs (*1*).

In 1952 Kerr (*2*) discussed the scientific information that might be gained from radar studies of the sun and planets, if sufficiently sensitive radar systems could be built. Others (*3*) have also discussed the importance of radar studies of the solar system and the magnitude of the required installations. But continuing advances in large antennas, high-powered transmitters, low-noise receivers, and data-processing techniques will soon make it possible to conduct important radar investigations out to distances which include essentially all of the solar system. The dramatic beginning of radar probing beyond the moon was announced last year when scientists at the Lincoln Laboratory of the Massachusetts Institute of Technology described the first radar detection of Venus (*4*).

The equipment and techniques for radar detection of the sun differ in several ways from those required for detection of the nearer planets. As Kerr has pointed out (*2*) a relatively low radar frequency is needed to avoid extensive absorption in the solar corona above the reflecting points. He estimates that the optimum frequency is near 30 megacycles per second. Much higher frequencies can be used to detect planets, so higher antenna gain can be obtained for a given antenna size. The new low-noise receiving devices, which are so important for radar sensitivity at the higher frequencies, are of no value at the lower frequencies where cosmic and solar noise limit the detectability of weak signals. In addition, the characteristics of solar noise differ from the better understood features of random receiver and cosmic noise, so care must be exercised in determining whether a solar echo has been obtained. These special features were expected to make radar detection of the sun very difficult, even though, because of the sun's size and despite its distance, a solar echo would be 100 times more intense than an echo from Venus.

Equipment and Test Procedure

For the April 1959 sun-echo tests a transmitter (Collins FRT-22) having about 40 kilowatts' average output power was operated at about 25.6 megacycles per second. The transmitter was pulsed on and off alternately throughout a time interval of 15 minutes, each on and each off period lasting 30 seconds.

The antenna system used for both transmission and reception consisted of four rhombic antennas in a broadside array, covering a rectangular area of 800 by 725 feet. The antenna gain is estimated to be 25 decibels relative to that of an omnidirectional antenna. The principal antenna beam is directed approximately east at an elevation of 10 degrees. The sun is in the antenna beam only for about 30 minutes soon after sunrise on a few days near each equinoctial period.

The travel time of a radar pulse to the sun (approximately 93 million miles away) and back to the earth is about 1000 seconds. At the end of the transmitting period of 900 seconds, the antenna was connected directly to the receiving system, and the transmitter and pulsing circuits were turned off. The receiver and its preamplifier are of conventional design. An intermediate frequency bandwidth of 2000 cycles per second was used, and this band was translated with the receiver beat-frequency oscillator so that its lower end was at zero frequency. The receiver was tuned to the transmitted frequency since the computed Doppler shift was less than 25 cycles per second. The output was recorded on magnetic tape for later detection and analysis.

Trials were scheduled for each morning from 5 to 13 April, inclusive. Because of various difficulties (for example, equipment failures, timing ambiguity, and radio interference), recordings suitable for intensive analysis were obtained only on 7, 10, and 12 April.

The test procedure for September 1958 differed in several respects from that described above. The recorded data have not yet been analyzed in detail. In September 1959, changes were made in the coding of the transmitted waves and in the antenna. The antenna modification was made for the need of the program for which the antenna was first constructed and was designed for short-pulse work only. A risk was taken in operating the modified antenna with

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the long pulse needed for the solar experiment. Data analysis was proceeding when it was discovered that certain antenna components had failed during the testing so that antenna performance was seriously impaired. Therefore interest was diverted to the April 1959 test results, and only these are discussed further.

Data Analysis and Results

Data analysis was conducted with an IBM 797 computer and associated equipment. The recordings made on 7, 10, and 12 April at 0 to 2000 cycles per second were sampled electronically 4000 times each second, and thus the data were converted from analog to digital form. The absolute values of the samples were summed for periods of one second, and these one-second sums were stored for further analysis. (By taking absolute values, the receiver output was detected in an ideal linear detector.) The longest usable echo time common to the three days is 12 minutes, or 720 one-second sums.

A square wave of period 1 minute, representing the transmitted wave, was cross-correlated with the 720 one-second sums for each day. That is, the sums 1 through 30 were added, 31 through 60 were subtracted, 61 through 90 were added . . . , and 691 through 720 were subtracted, to obtain one point of the cross-correlation curve. The next point was obtained by adding the sums 2 through 31, subtracting those from 32 through 61, and so on, the first one-second sum being included with the subtraction of the sums 692 through 720. After 60 cross-correlation points were obtained in this way, the values would start to repeat, so only 60 points (seconds) were computed. The cross-correlation curves that result are shown in Fig. 1.

Curves *a*, *b*, and *c* in Fig. 1 show the cross-correlation curves for 7, 10, and 12 April, respectively, and curve *d* is a composite curve for the three days.

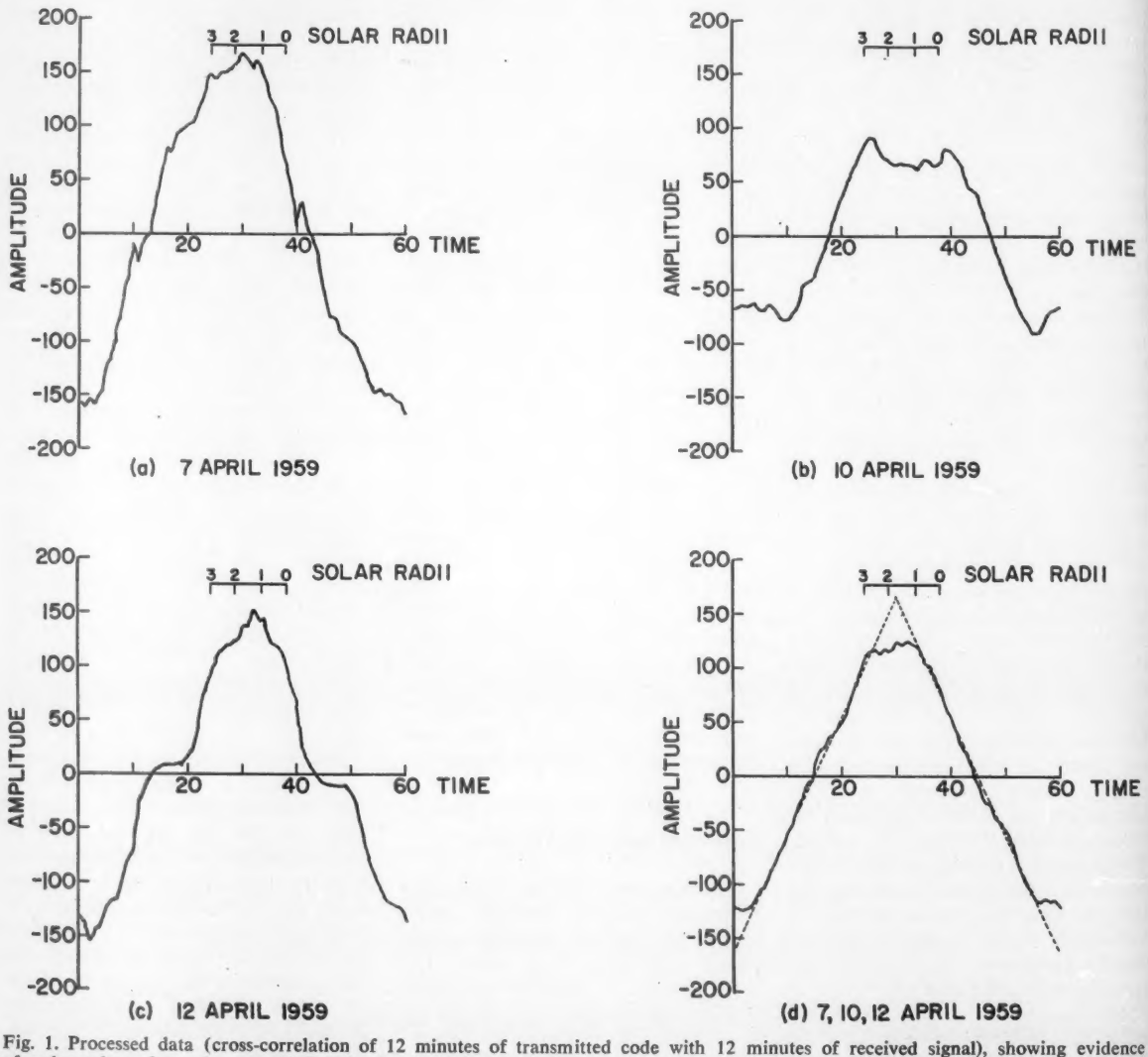

Fig. 1. Processed data (cross-correlation of 12 minutes of transmitted code with 12 minutes of received signal), showing evidence of radar echoes from the sun. (*a*) Results for 7 April; (*b*) results for 10 April; (*c*) results for 12 April; (*d*) combination of all data compared with an ideal echo curve. The ordinate is relative amplitude in arbitrary units, and the abscissa is relative time in seconds.

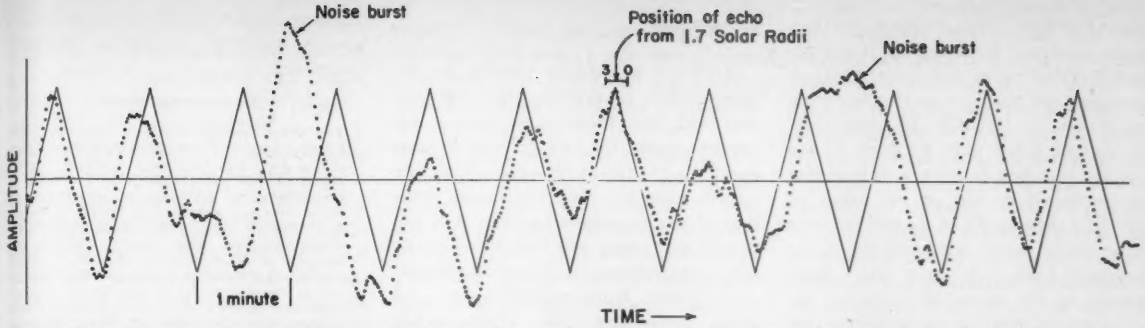

Fig. 2. Processed data (cross-correlation of 1 minute of transmitted code with 12 minutes of received signal), showing individual echo returns and disturbing noise bursts compared with ideal echo curve for 7 April 1959. Curve *a* in Fig. 1 is derived from these data. The ordinate is relative amplitude in arbitrary units, and the abscissa is relative time in seconds.

If there were no noise but if there were echoes from a discrete target, the cross-correlation curve would be one cycle of a perfect triangular wave with crests at a position determined by the target range. The dashed Λ-shaped curve shown in Fig. 1*d* represents this ideal condition. If the target were large and echoes were returning from several ranges, the peaks of the Λ curve would be less sharp, but the sides would still be straight. If there were random noise and no echoes present in the samples, the cross-correlation curve would fluctuate over a small range near the zero ordinate. In fact a noise sample of the same rectified average as the solar-echo samples has been subjected to the same receiver, recorder, and computer processing as was used for the radar returns, and the maximum deviation from zero was 16.5 decibels below the peak of the ideal Λ curve.

While it is evident that random (Gaussian) noise could not produce amplitudes comparable with those observed in the cross-correlation curves, strong impulse and burst noise from the sun can produce wide fluctuations in curves of this type. Thus special care must be exercised in interpreting Fig. 1.

In a later paragraph is discussed a different treatment of the April data which leads to numerical probabilities very nearly equal to unity that solar echoes were obtained. Immediately below are five strong arguments to indicate that the curves of Fig. 1 represent the successful radar detection of the sun.

1) *Position of the peaks.* Solar noise is equally likely to produce a peak in the cross-correlation curve at any point along the time base. The ideal Λ curve of Fig. 1*d* is drawn at a position corresponding to an assumed reflection at 1.7 solar radii. A scale corresponding to reflection points from 0 to 3 solar radii is shown over the positive crest of each curve. It can be seen that the position of *each* cross-correlation peak corresponds to reflection near the positions that would be expected from computations such as those of Kerr (*2*).

2) *Symmetry.* While the cross-correlation curves must have an inverted repetition at 30 seconds, solar noise would not in general produce a mirror symmetry about any time coordinate. If echoes are present there should be such mirror symmetry about the peak time, and this shape is evident in the curves of Fig. 1.

3) *Linearity of the sides.* Again, solar noise would not in general produce linear sides, while echoes would.

4) *Improvement in composite curve.* If the curves for the individual days contain both signal and noise, the composite curve for the three days should be a closer approximation of the ideal signal (Λ) shape. This is very strikingly evident in the figure.

5) *Signal-to-noise ratio.* In comparison with the hypothetical system described by Kerr (*2*), the present system should obtain sun echoes at a signal-to-noise power ratio of about –22 decibels in the intermediate frequency amplifier, or –44 decibels immediately after the detector. This rough computation was made just a few hours before the sums of the 7 April run were available. These sums indicate a ratio of mean signal-to-noise voltage before post detection integration of 1/155, or, if mean power is approximately the square of mean voltage, a power of –43.8 decibels. The closeness of these two figures cannot be considered anything but fortuitous, but the fact that they are within even 10 decibels of each other is significant. The signal-to-noise power ratios before integration for 10 and 12 April are –48.8 and –44.8 decibels, respectively. The computer program has been checked with test signals for signal-to-noise ratios near these values.

A clearer understanding of the effects of impulse and burst noise from the sun can perhaps be obtained from attempts to detect each individual solar echo instead of the integrated effect of many echoes. Figure 2 shows the cross-correlation of a single cycle of a square wave with 12 minutes of the one-second sums of April 7. The ideal triangular curve, placed at a position corresponding to reflection at 1.7 solar radii, is shown for comparison. (There is a range ambiguity of about 13 solar radii based on the 60-second periodicity of the transmitted wave, but it is not believed that the reflection could be this far from the sun.) There are serious disruptions from the ideal curve near the third and ninth cycles, but the cross-correlation curve always returns approximately to the ideal position and shape. Such disruptions could be caused by outbursts of solar noise.

In an attempt to express numerically the probability that solar echoes were obtained, curves like those shown in Fig. 2 were also made for 10 and 12 April, and for several periods in April and September 1959 when only noise was present. That is, a limited amount of data has been obtained on solar noise alone to compare with the periods when signals may be present. It is felt that the positions of the peaks in the cross-correlation curves are more significant than their amplitudes for differentiating between signal and impulsive noise. From the limited data on noise it appears that the positions of the peaks, referred to the same one-

minute period, have Poisson distributions, as would be expected. If a Poisson distribution of the noise peaks is assumed, the positions of the measured peaks on 7, 10, and 12 April, expressed in solar radii between 0 and 13, are bunched to such a degree that the probabilities are on the order of 10^{-4} that they could be caused by solar noise alone. Since the position of the bunched peaks for each day corresponds to the expected range of the reflecting regions, the probabilities that solar echoes were obtained on each day are very nearly unity, being about 1 to 10^{-5}. This result is for each day considered independently. Since similar results were obtained on all three days, the total probability of success is even much nearer unity.

From a preliminary analysis of the spectrum received it appears that the echo energy is spread over at least 2000 cycles per second. Solar rotation alone could account for much of this Doppler broadening, but gross motions in the solar corona would also be expected to produce a wide echo spectrum.

Conclusions

There is a growing interest in the potentialities of probing the solar system with man-made radio waves. An obvious name for this field of investigation is "radar astronomy." With the added versatility inherent in the control of the transmitted waves, it is expected that much will be learned which will complement and extend knowledge gained from passive visual and radio astronomy, and from rocket probe measurements.

The scientific information about the sun gained from the first radar experiments, described above, is very limited. However, it is now possible to plan with confidence the systems and test procedures needed for more meaningful radar studies of our dynamic sun. From the time variability of the echo strength, delay, polarization, and spectrum, much will surely be learned about the constantly changing solar phenomena which affect so vitally the earth and its surroundings. More sensitive installations that will be suitable for solar and other studies in radar astronomy are now under construction at several locations, including Stanford University.

References and Notes

1. The work reported here was supported principally by the Electronics Research Directorate of the Air Force Cambridge Research Center, under contract AF-19(604)2193. We wish to acknowledge in particular the assistance of Philip Newman and the late Joseph P. Casey, Jr., of that center. The solar experiments would not have been possible without the existence at Stanford of facilities built up for several other research programs. The antenna system was constructed for ionospheric research under the direction of O. G. Villard, Jr., with support from the Office of Naval Research under contract Nonr-225(33). T. V. Huang, W. A. Long, and others provided valuable assistance in the transmitting-receiving phase of the tests. The data processing facility was organized through the efforts of A. M. Peterson, with the assistance of R. D. Egan and D. S. Pratt. The IBM 797 unit was a gift from the International Business Machines Corp. to Stanford University for use in electrical engineering and mathematical research programs.
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Cosmic-Ray-Produced Silicon-32 in Nature

Silicon-32, discovered in marine sponges, shows promise as a means for dating oceanographic phenomena.

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The nuclear transmutations resulting from the interaction of cosmic rays with nuclear species in the atmosphere have produced a variety of radioactive products detectable on the surface of the earth. Such isotopes as C^{14}, H^3, Be^{10}, and P^{32} have been found, and their individual distributions and concentrations in the various geological domains have led to many significant concepts and contributions in geochemistry, geophysics, and geochronology (see, for example, *1*).

This article (*2*) concerns still another isotope produced by cosmic rays—Si^{32}, which we have detected in the marine environment. It is thought that this isotope is produced from the nuclear spallations of argon by cosmic rays. It has a half-life of roughly 710 years (*3*). Any Si^{32} that reaches the earth from the atmosphere will be rapidly diluted with stable silicon, and the resulting specific activity of Si^{32} will be very small. However, Si^{32} decays by negatron (β^-) emission to P^{32}, which is a negatron emitter with a half-life of 14.3 days. This makes it possible to detect Si^{32} by milking and by counting the P^{32} daughter from large amounts of silicon.

The principal exchange reservoir for Si^{32} is probably the marine hydrosphere which most likely receives Si^{32} via oceanic rains. The small amounts of silicon in surface marine waters should yield a relatively high specific activity of Si^{32}, whereas the fallout on land will be so diluted by exchange and other chemical interactions with the exposed crustal materials that the detection of this nuclide will be extremely difficult. We estimate the average concentration of Si^{32} to be 2.6×10^{-5} disintegrations per minute, per liter of sea water, or 8 disintegrations per minute, per kilogram of silicon, for a hypothetical thoroughly mixed ocean. The amount of sea water required to yield 1 disintegration per minute, an activity conveniently detectable, is 3.8×10^4 liters. Since the handling of such an amount of water for the extraction of silicon presents many difficulties, Si^{32} was sought initially in siliceous (opaline) sponges, which derive

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their silicon from sea water and are available in abundance, especially on the sea floors of the continental shelf. Three sponges trawled from the Gulf of California in 1956 were analyzed.

The experimental techniques and the results are presented in the next section. In the third section, an estimate of the rate of production of Si^{32} in the atmosphere from the available cosmic ray and accelerator data is presented. The applications of Si^{32} as a tracer for studying geochemical and geophysical processes with special reference to oceanography are discussed in the last section.

Experimental Techniques and Results

Chemical procedure. The sponges were first cleansed of organic matter and foreign materials, not incorporated in the opaline structure, by digestion with nitric acid, followed by repeated washings with water and acetone. Approximately 200 grams of this material was allowed to stand for 3 months to allow the P^{32} to build up.

The milking procedure was initiated by treating the sample (after grinding) with a 50 percent solution of sodium hydroxide containing a known amount of carrier phosphate, in a polypropylene beaker. The solution was heated to speed up the dissolution. Hydrogen peroxide was added to remove any interstitial organic matter which was released during the breakdown of the opal. At this point approximately 95 percent of the silicon was in solution; the remaining 5 percent was treated with hydrogen fluoride and sulfuric acid, and heated to near-dryness; finally the residue was dissolved in HNO_3.

The dissolved silicon in the NaOH solution was dehydrated to the SiO_2 form by the addition of 400 ml of concentrated hydrochloric acid and filtration through a Büchner funnel. The silica was dried at 130°C and washed thoroughly with dilute HCl to remove any adsorbed phosphorus compounds. The filtrate, washings, and the solution resulting from the treatment with HF and H_2SO_4 were combined and evaporated until the sodium chloride had crystallized out. The salt was removed by filtration through a sintered glass funnel and washed with concentrated HCl. These evaporation steps were repeated twice to remove the bulk of the NaCl. The final filtrate was taken to dryness, digested with 6*N* HCl, and dehydrated. This step was repeated twice to render insoluble any remaining traces of silica. The residue was heated with perchloric acid to dryness, and dissolution was effected in 20 ml of concentrated HNO_3.

The phosphorus was extracted from the above solution and purified by the following steps carried out in accordance with often published standard procedures (*4*): (i) phosphoammonium molybdate precipitation; (ii) magnesium ammonium phosphate precipitation; (iii) elimination of cations by passage through a Dowex-50 cation exchange resin in the H-form; (iv) magnesium ammonium phosphate precipitation; and (v) ignition to magnesium pyrophosphate. This solid was assayed for its radioactivity.

After an initial counting, the sample was subjected to additional chemical purification by a repetition of the last four steps. The silica recovered in the dehydration step was milked again after a period of 28 days.

Counting techniques. The samples were deposited over an area of approximately 6 cm^2 on two split cylindrical copper supports and counted in a cylindrical geometry with a thin-wall, flow-type Geiger tube with "Q gas" (98.7 percent He; 1.3 percent isobutane). The details of the counter have been described by Martell (*5*). The counter was housed in a shield which provided a minimum of 8 inches of steel on all sides and was operated in anticoincidence with a ring of large cosmic ray counters to eliminate the recording of cosmic ray μ-mesons. The background counting rate with blank copper supports was 0.26 count per minute. The counting efficiency for hard beta rays was determined by assaying a weighed sample of potassium chloride for K^{40} β-radiation ($E_{max.} = 1.34$ Mev) under conditions similar to those employed for our samples. The over-all counting efficiency, which includes the counting geometry, back-scattering from the support, and absorption in the counter wall, was found to be 37 percent.

Several blank runs were made to ascertain the amount of contamination arising from chemical reagents and dust in the laboratory. The net counting rates of the blanks varied between 0 ± 0.05 and 0.05 ± 0.04 count per minute. A small, but positive, blank of 0.025 count per minute resulting from man-made or natural activities is indicated.

Results. The chemical yields of phosphorus and the activities of Si^{32} are summarized in Tables 1 and 2, respectively.

Table 1. Chemical yields.

Sample No.	Remarks	Dry sample weight (gm SiO_2)	Amount of carrier added (mg $Mg_2P_2O_7$ eq.)	Yield (%)
1	First milking	200	120	92
1R	First milking recycle			83
2	Second milking	190*	135	66

* Five percent of sample 1 did not dissolve in NaOH treatment. It was treated with HF and H_2SO_4, and therefore was not available for the second milking.

Table 2. Counting data.

Period of milking	Net sample counting rate (count/min)	Time elapsed between end of milking and counting (day)	Estimated No. of disintegrations of Si^{32} per minute, per kilogram of Si *
	Sample No. 1		
3 mo	0.52 ± 0.07	2	20.0 ± 2.7
	Sample No. 1R		
	0.36 ± 0.04	4	
	0.41 ± 0.05	7	
	0.28 ± 0.04	13	19.9 ± 1.7
	0.21 ± 0.04	20	
	0.11 ± 0.03	28	
	Sample No. 2		
28 days	0.26 ± 0.04	2	18.9 ± 2.9
			Mean 19.6 ± 1.3

* Self-absorption in the sample was assumed to be 6 percent in all cases.

The observed activity of the samples can be unambiguously attributed to the presence of P^{32} on the basis of the following four independent checks on the nature of the radiation:

1) *Half-life.* The activity of sample 1R was followed for a period of two half-lives of P^{32}. The counting data are assembled in Table 2. The observed half-life of the activity, 13 ± 4 days, is in good agreement with the literature value for P^{32}, 14.3 days.

2) *Chemical behavior.* Sample 1 was recycled through the purification steps 1 to 4 with the result that the specific activity of the recycled sample remained unchanged within the errors of measurement (Tables 1 and 2).

3) *Beta energy.* Absorption measurements of sample 1, with vinyl acetate absorbers of thicknesses 51 and 102 mg/cm², yield a half-thickness value of 75 ± 20 mg/cm². The P^{32} half-thickness for cylindrical counting geometry had previously been found to be 84.3 mg/cm² of aluminum (*6*). The vinyl acetate half-thickness, in milligrams per square centimeter, is expected to be about 13 percent higher than that for aluminum absorbers. The thinness of the samples, coupled with appreciable backscattered radiation, on the other hand, should yield a slightly smaller half-thickness. In view of this, the energy of the beta radiation is consistent with that of P^{32} (*7*).

4) *Growth of daughter activity.* The estimated disintegration rates of Si^{32} from the first and second milking are concordant.

These results prove conclusively that the observed activity is due to P^{32} and that it arises from the decay of the parent nuclide Si^{32}.

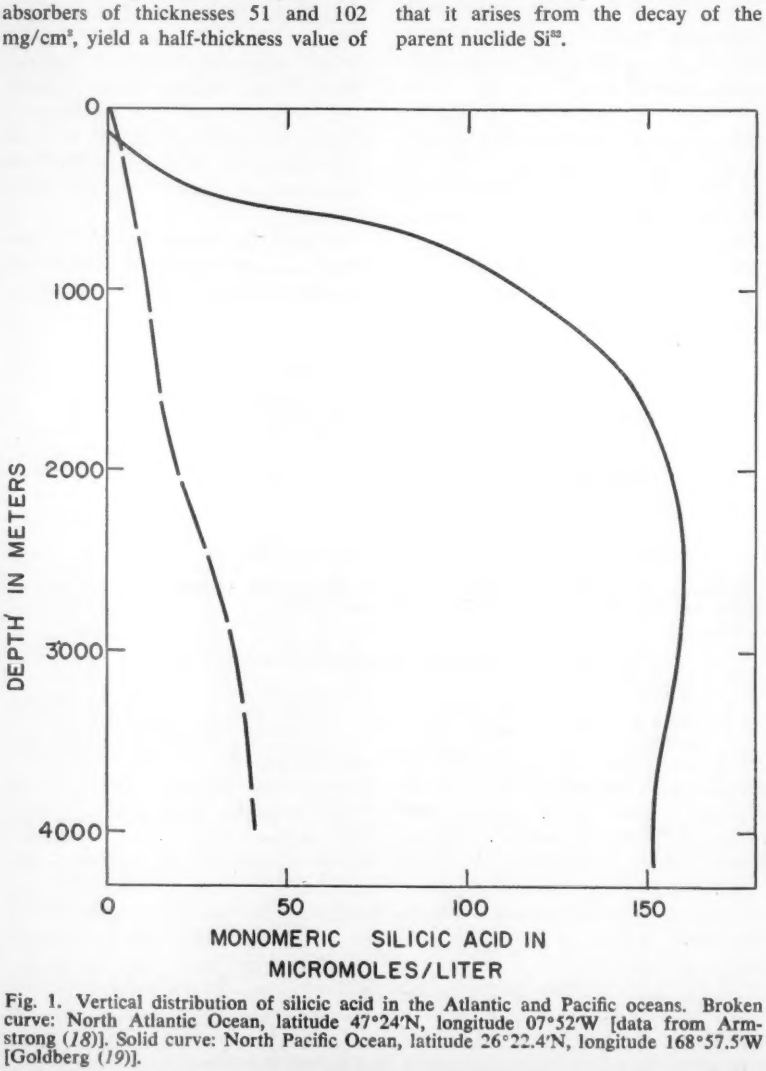

Fig. 1. Vertical distribution of silicic acid in the Atlantic and Pacific oceans. Broken curve: North Atlantic Ocean, latitude 47°24′N, longitude 07°52′W [data from Armstrong (*18*)]. Solid curve: North Pacific Ocean, latitude 26°22.4′N, longitude 168°57.5′W [Goldberg (*19*)].

Rate of Production of Silicon-32

The production rate of Si^{32} can be calculated from the available cosmic ray data, in different regions of the atmosphere, on (i) the star production rates in photographic emulsions and cloud chambers; (ii) the frequency distribution of stars as a function of the number of charged particles emitted; and (iii) the observed variation in the intensity of slow and fast neutrons. Lal *et al.* (*8*) have calculated the production rates of P^{32}, P^{33}, and S^{35} in spallations of atmospheric argon for all regions of the atmosphere from such data. By their procedure, the global production rate of Si^{32} is computed to be 1.7×10^{-4} atom/cm² column per second.

A second estimate can be made by using the observed fallout of cosmic-ray-produced P^{32} and the expected ratio of cross sections for the production of Si^{32} and P^{32} from argon at energies of interest in cosmic rays. The fallout of P^{32} was measured at tropical latitudes during the years 1956–58 (*9*) to be 3.4×10^{5} atoms of P^{32}/cm² per year. This value is shown to be predominantly due to the removal by wet precipitations of activity produced in the troposphere only, with a mean removal period of 40 days. By correcting this figure for the decay of P^{32} in the troposphere and taking a value of 29 percent for the fraction of P^{32} produced below the tropopause (*8*), a production rate for P^{32} of 1.1×10^{-5} atom/cm² per second is obtained. The ratio of the cross sections of Si^{32} and P^{32} is computed to be 0.2 from Rudstam's empirical relation (*10*) describing the cross sections for the formation of nuclides in nuclear spallations.

The ratio of formation cross sections for two isobars, (A,Z) and (A,Z'), depends on two parameters only:

$$\sigma(A,Z)/\sigma(A,Z') = \exp\{-R[(Z-SA)^2-(Z'-SA)^2]\} = \exp[R(Z'-Z)(Z'+Z-2SA)]$$

The values of the parameters R and S are found to be nearly insensitive to either the bombarding energy or the target nucleus for masses between 51 and 75. In order to approximate our situation, we have used the values observed in the bombardments of vanadium by 60-, 100-, 170-, 175-, and 240-Mev protons: $R = 1.6 \pm 0.1$; $S = 0.468 \pm 0.001$. Therefore the ratio of cross sections is

$$\sigma(Si^{32})/\sigma(P^{32}) = \exp[R(Z+Z'-2SA)] = 0.2 \pm 0.02$$

The production rate of Si^{32} therefore

amounts to $0.2 \times 1.1 \times 10^{-6} = 2.2 \times 10^{-4}$ atom/cm² per second, which is in good agreement with the previous estimate (1.7×10^{-4}).

We take 2.0×10^{-4} atoms/cm² per second as the average global production rate of Si^{32} in the atmosphere. The corresponding inventory of Si^{32} on the earth is 28 kilocuries, or 1.75 kg of Si^{32}.

The production of Si^{32} in any significant quantities by nuclear weapons seems quite improbable but cannot be entirely ruled out at present. It cannot result from surface shots by principal neutron capture reactions, (n, γ), (n, p) (n, a), since the target nuclides involved are short lived and do not exist in nature. However, it could be produced in the bomb hardware by successive neutron capture reactions. Unfortunately we cannot estimate this contribution. The total amount of Sr^{90} produced till the end of 1958 has been estimated to be 63.5 kg (*11*). If Si^{32} has been produced in bombs, its natural inventory could be raised by 10 percent if it amounts to as much as ~ 1 percent of Sr^{90} in nuclear weapons.

Geochemical Considerations

The geochemical behavior of silicon has been extensively studied not only because it is one of the principal rock-forming elements but also because it is involved both in the biological and inorganic reactions in the major sedimentary cycle. The following brief summary of present knowledge of silicon geochemistry provides an entry into the problem of the distribution of Si^{32} among the earth's geological domains following its formation.

Crustal rocks are decomposed by various weathering agents, resulting in the solution of silicon, the formation of new minerals containing silicon, and the accumulation of resistant minerals such as quartz, feldspar, and so on (see, for example, Pettijohn, *12*). The two groups of solid phases are transported to the marine environment through the atmosphere and the hydrosphere. The river load of solids is deposited primarily in the near-shore areas, while the eolian minerals, originating mainly from the arid desert areas, fall to the sea floor in mid-latitudinal belts extending across the oceans (*13*).

The dissolved silicon exists nearly entirely as undissociated monomeric silicic acid, $Si(OH)_4$, in both river and marine waters and is in an undersaturated state (*14*). Typical depth distributions in sea water are shown in Fig. 1. The acid is depleted in the photosynthetic zone (upper 100 meters or so) by microscopic organisms such as diatoms, radiolaria and silicoflagellates, which incorporate it into their opaline skeletons. This effect is extended to greater depths by the wind mixing in the upper layers of the oceans, such that waters down to 300 or 400 meters or more can have minimal values of silicon. The combustion of the plant materials which settle from the euphotic zone results in the dissolution of the silicon dioxide at intermediate depths. A maximum in the depth profile arises from the greater amounts of regeneration in warmer waters—that is, depths less than 1000 meters or so.

On the basis of the chemical properties of silicon, it is probable that Si^{32} is involved primarily in the solution geochemistry of silicon. From the chemistry of silicon, we expect that whatever molecular species are formed initially after the production of single atoms of Si^{32}, interactions with water droplets during condensations will finally lead to the formation of $Si(OH)_4$. Single molecular species of silicon such as SiO_2 will be unstable with respect to $Si(OH)_4$ since they cannot form aggregates. Such a situation is probably not too dissimilar to that of cosmic-ray produced Be^7, which is found to exist in rain water as soluble species.

With the foregoing discussions in mind, we can consider the radiosilicon balance in the oceans. Simplified models for oceanic circulation for the case of

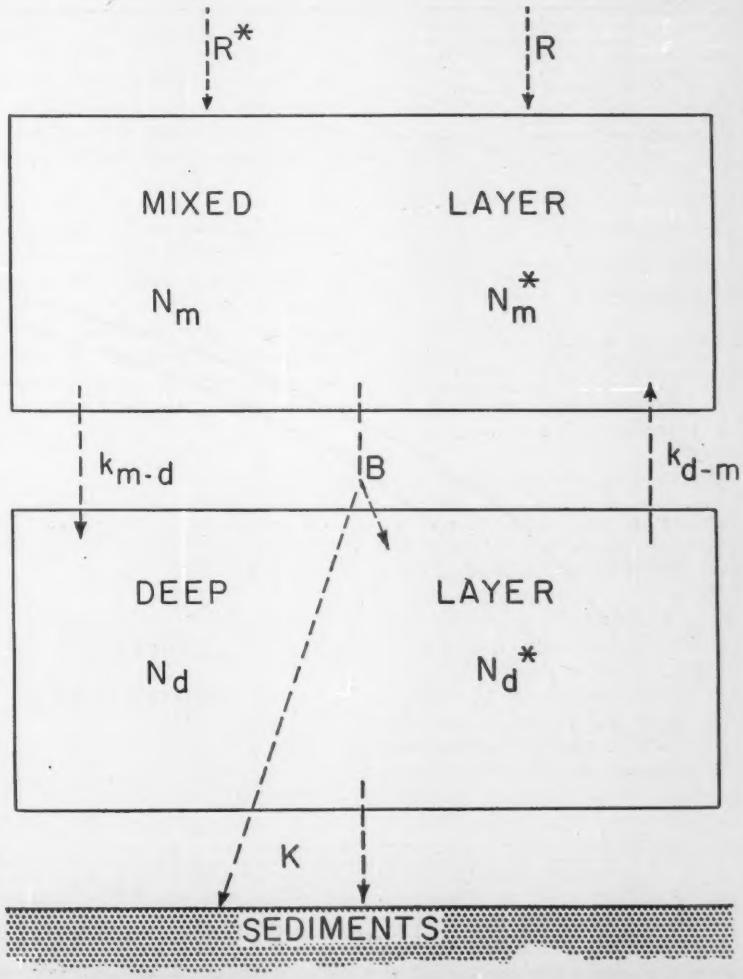

Fig. 2. Simplified model of silicon reservoirs in the exchangeable system.

C^{14} have recently been discussed (*15, 16*). We adopt the model of mixing and transfer processes in the oceans proposed by Craig (*16*). The oceans are divided into two principal reservoirs called the mixed (*m*) and deep (*d*) layers which are assumed to be *well mixed internally*. A steady state is reached by the exchange or transfer of silicon between the reservoirs (Fig. 2). The mixing cycle of *soluble silicon* is considered. As usually is the case in such models, the exchange of isotopes of very low abundance is governed by first-order kinetics, and the exchange rates of dominant species can thus be calculated. The following definitions are used: N_m and N_d are the amounts of silicon in the mixed and deep layers, respectively; N^*_m and N^*_d are the amounts of Si^{32} in the mixed and deep layers, respectively; R and R^* are the rates of introduction of silicon and Si^{32} into the oceans, respectively; k_{m-d} and k_{d-m} are the rate constants for the mixing of soluble silicon between the mixed and deep layers, and the deep and mixed layers, respectively; K is the rate constant for removal of silicon from ocean to the sediment; B is the rate constant for removal of silicon from the mixed layer by biological precipitation of solid siliceous phases (part of the precipitated silicon which does not dissolve at greater depths in the oceans reaches the sediments directly; see Fig. 2); and λ is the disintegration constant of Si^{32}. Therefore, $\lambda = 0.693/710 = 1 \times 10^{-3}$ yrs^{-1} (*3*).

By our definitions, we obtain the following relations for a steady state:

$$R = (N_m + N_d)\,K \qquad (1)$$

$$\frac{dN_m}{dt} = O = R - k_{m-d}N_m + k_{d-m}N_d - BN_m \qquad (2)$$

$$R^* = (K + \lambda)(N^*_m + N^*_d) \qquad (3)$$

$$\frac{dN^*_m}{dt} = O = R^* - k_{m-d}N^*_m + k_{d-m}N^*_d - BN^*_m - \lambda N^*_m \qquad (4)$$

Solving these equations, we find:

$$\frac{N_m}{N_d} = \frac{K + k_{d-m}}{B + k_{m-d} - K} \qquad (5)$$

$$\frac{N^*_m}{N^*_d} = \frac{K + \lambda + k_{d-m}}{B + k_{m-d} - K} \qquad (6)$$

The ratio of the specific activities in

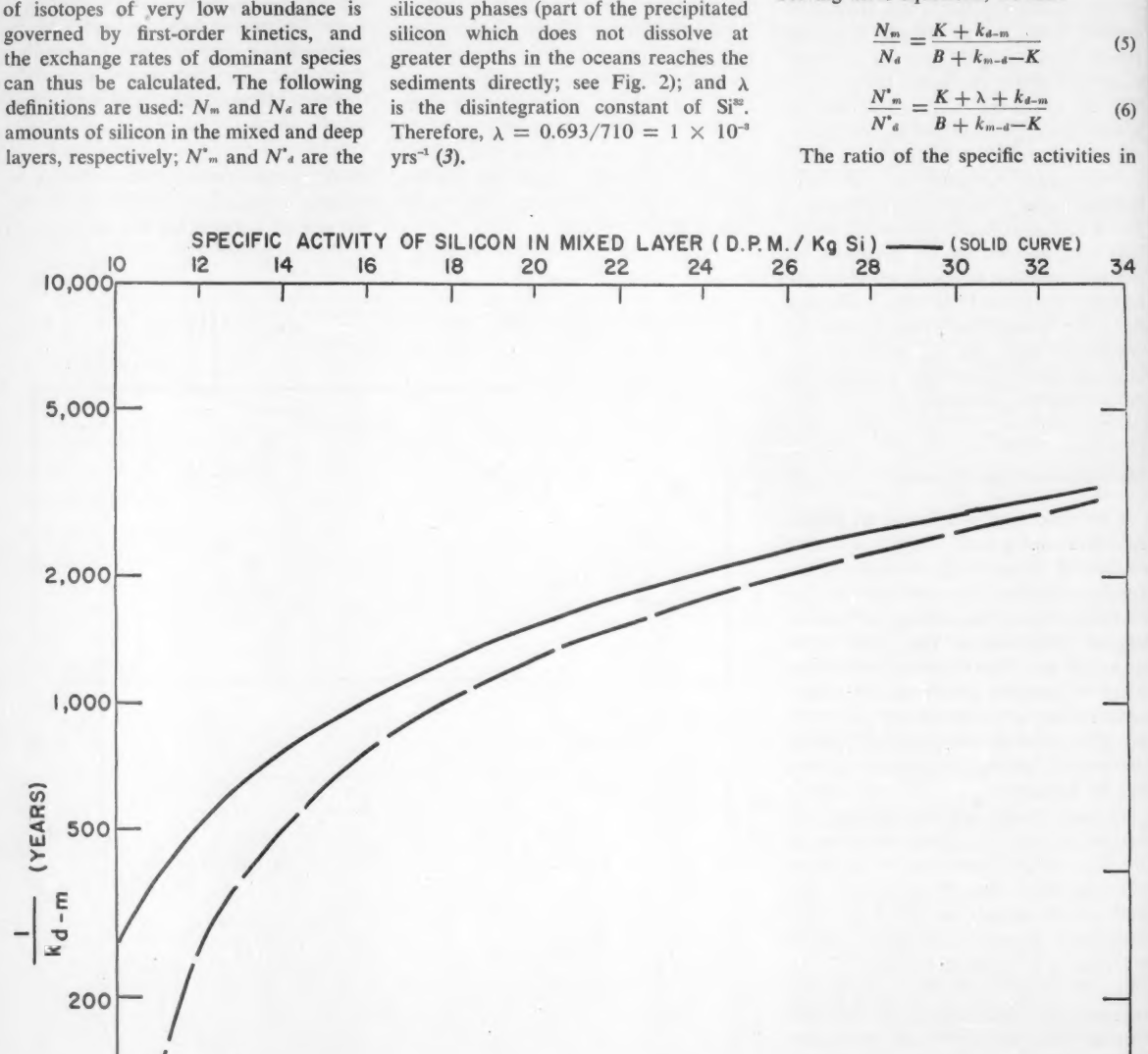

Fig. 3. Calculated specific activities of Si^{32} in the mixed and deep layers as a function of k_{d-m}.

the mixed and deep layers is readily obtainable as:

$$\frac{N^*_m/N_m}{N^*_d/N_d} = \frac{K + \lambda + k_{d\text{-}m}}{K + k_{d\text{-}m}} \quad (7)$$

Goldberg and Arrhenius (*17*) have computed a value of 10^{-4} yr^{-1} for K. Since this refers to both the soluble and particulate forms of silicon, a reduction by a factor of 2 of the rate of introduction of silicon based on an induction of Rex and Goldberg (*13*) that up to 50 percent of the silicon enters the oceans in solid phases, gives a more realistic figure of 5×10^{-5} for K. Since K is many orders of magnitudes smaller than other exchange coefficients, uncertainty in K does not affect our model calculations.

A plot of the ratio of the specific activities of Si^{32} in the mixed and deep layers, calculated from Eq. 7, versus $1/k_{d\text{-}m}$ is shown in Fig. 3. It is quite clear from the graph that this potentially measurable ratio is a quite sensitive indicator of the rate of mixing of deep waters into the mixed layer. It is of interest to note that this ratio is independent of the production rate of Si^{32}. In the same figure, the expected specific activity of Si^{32} in the mixed layer ($\lambda N^*_m/N_m$, obtained by solving Eqs. 3 and 7, is plotted, taking for R^* a value of 1.7×10^{-4} atom/cm^2/per second. The average silicic acid contents of deep and mixed layers are taken as 120 and 15 micromoles per liter, respectively.

The observed specific activity of 19.6 disintegrations per minute, per kilogram of Si, represents principally a value for the mixed layer, inasmuch as the sponges were retrieved from coastal waters of depths under 100 meters. This corresponds to an average mixing time (that is, $1/k_{d\text{-}m}$) of more than 1500 years on the basis of the discussed model.

The quantitative significance of a photosynthesizing siliceous organism in the soluble silicon cycle in the sea can be readily seen by solving Eq. 5 for the biological removal constant B:

$$B = \frac{N_d}{N_m}(K + k_{d\text{-}m}) + (K - k_{m\text{-}d}) \quad (8)$$

By taking a ratio of 49.6 for the volumes of deep to mixed layers (*16*), a value of 397 for N_d/N_m is found. It is apparent that the second term is trivial compared with the first and can be neglected; furthermore, since K is small compared with $k_{d\text{-}m}$,

$$B \approx 397\, k_{d\text{-}m} \quad (9)$$

For likely values of $k_{d\text{-}m}$, say between 2×10^{-5} and 5×10^{-4} yr^{-1}, values of B range between 0.8 and 0.2—that is, the silicon is removed from the mixed layer to deep layers or sediments due to biological activity in mean periods of 1 to 5 years.

In addition to studies of mixing times in the oceans, there are other obvious applications of this isotope as a tracer for studying problems in earth sciences: (i) the rates of accumulation of rapidly growing sediments containing large amounts of biogenous or hydrogenous siliceous phases; (ii) the individual characteristics of water masses within oceans with respect to mixing; (iii) the silicon cycle in the continental hydrosphere; (iv) changes in cosmic ray intensity with time during the last few thousand years; (v) ages of the polar ice caps.

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Ross Granville Harrison, Experimental Embryologist

Ross Granville Harrison, born in Germantown, Pa., on 13 January 1870, died 30 September 1959. In his 89 years of life he encompassed an era of science in which he found absorbing interest. His early schooling was in Germantown and then in Baltimore. When he entered Johns Hopkins University it was as an undecided undergraduate who was interested in gaining as much general knowledge as possible. He spent many hours browsing in the library. Later he had his own library facilities, and to the end of his intellectual life he enjoyed browsing in literature at a specialist's level.

Harrison's father was an engineer and was called upon to carry out many major engineering projects abroad. One of these was the construction of Russian railways, in the course of which he had to map part of the trans-Siberian railway in order to determine the characteristics of the railbed over this vast and then uncharted land. Ross' son, Richard Edes Harrison, is the recognized leader in modern cartography.

During Harrison's early childhood his mother died and his care devolved upon an aunt. This probably developed in him an early realization of his individuality. He felt early that he was the master of his own destiny. He realized that his father was abroad because of his business and professional problems, so he had no feeling of neglect.

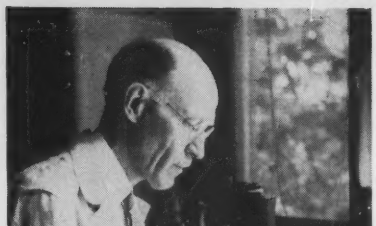
He may not have wished it so, but he accepted the situation without question. During this period he was known as one who walked alone, for he thought nothing of starting out on a 20-mile hike and later of touring most of Maryland and Pennsylvania on a bicycle.

His standing at Hopkins and his interest in biology led him to choose his graduate work in biology, with W. K. Brooks as his teacher. His experience during that period brought him in touch with E. G. Conklin, T. H. Morgan, D. H. Tennent, and others of Brooks' students. His reverence for Brooks was unspoken but real. Brooks' picture hung in his laboratory, and the stories which he told of Brooks, while whimsical, were always related with exceptional respect.

Harrison received his Ph.D. at Hopkins in 1894; his thesis was on the embryological origin of the rays of the fins of teleost fishes. This morphological study was to lead him to study of the paired fins and, later, to his classical work on asymmetry. In the fall of 1894 he went to Bryn Mawr as an instructor and lecturer in morphology. After a year in Germany (1895–96) he returned to Hopkins, as a member of the department of anatomy in the medical school. This was the time when the medical school at Hopkins was becoming the prototype of modern medical schools, with Welsh, Osler, Kelly, Halsted, and Martin on its staff. Mall headed the department of anatomy, with Harrison, Warren Lewis, Lewellys Barker, and Florence Sabin. It was a stellar group.

After several years of teaching, Harrison returned to Germany and earned his M.D. at the University of Bonn in 1899. On his first trip to Germany he had met Ida Lange, whom he married in 1896. From this time on, even as the family grew, all went to Germany each summer. Some of the crossings were strenuous, but during the summers of work and relaxation many of Harrison's acquaintanceships grew into lasting friendships. Of these, I will mention only a few: Sedgwick, Martin, and Bateson in England; M. Nussbaum, Driesch, and Spemann in Germany; Guiseppe Levi in Italy; and Przibram in Austria. These associations, together with his friendship for Anton Dohrn of Naples, were to prove valuable relationships.

When he left Hopkins in 1907 to become Bronson professor of comparative anatomy at Yale, Harrison was at the beginning of a career which lasted far beyond his academic retirement. When he came to Yale he had President Hadley's promise that a new and really modern laboratory should be built for the university department of zoology. Temporarily Harrison's activities were housed in the old Sheffield mansion, which had been adapted for laboratory use. In it were housed all the ancient facilities and many of the past faculty members, such as Sidney Smith and A. E. Verrill, who were still active, although Smith was almost blind. In an adjacent wing the departments of physiological chemistry, established by Russel H. Chittenden and then headed by Lafayette B. Mendel (with F. P. Underhill), and bacteriology, headed by Leo Rettger, were housed. Chittenden was director of the Sheffield Scientific School and nominally had charge of the departmental appointments which Harrison might wish to make. Wesley R. Coe was the only other active member of the zoology department when Harrison took over.



Ross Granville Harrison

Within a relatively short time Harrison recruited a staff consisting of L. L. Woodruff and A. Petrunkevitch which, with Coe and himself, was able to carry on the work as it was then scheduled at 1 Hillhouse Avenue. He was fortunate in his choice of men. Coe proved to be of the greatest assistance both in planning the new department which Harrison envisaged and in carrying through the necessary readjustments. Woodruff was brought to Yale from Williams, where he had established a reputation as a stimulating undergraduate teacher. This reputation was upheld during his life at Yale, and thousands of Yale men secured a scholarly and inclusive introduction to biology through his "Biology 10." The department, in the more than a decade since he relinquished the course, has progressed numerically from Biology 10 to Biology 11 without being able to increase the content or improve the scholarly approach. Petrunkevitch was brought to Yale from Indiana University. He had fled from Russia to Germany, where he studied under the great Weismann. He has since come to be the world's greatest arachnologist. Harrison had good men with him, and they were then, and throughout his career, loyal to him. His attainment warranted their respect, and his treatment of them commanded their loyalty.

But this was not Harrison's only contribution. He demanded of the administration that the science departments be made university departments, and the demand was met. There was for him no division of the academic from the scientific, for do not both together constitute knowledge of the world in which we live? He was more modern in his viewpoint than he thought.

As new branches of zoology appeared he added specialists to the staff: E. C. MacDowell in genetics, Renald Spaeth in the physiology of smooth muscle, Henry Laurens in special sense physiology, B. W. Kunkel in modern morphology, and T. S. Painter in cytology. These men added to the teaching and research potentials of the new Osborn Laboratory, which now was a reality.

Harrison, after securing a laboratory for zoology, insisted that botany be added in an adjoining wing, where it is still located, the facilities of both departments being thus made accessible to students in a real biological sense. Completion of the Osborn laboratories required two years during which Harrison had made daily inspections of construction and had met constantly with the architect to discuss revisions and remodeling to meet changing needs. He planned at least 20 years in advance of his time.

Harrison's training of students was founded on F. P. Mall's system, known to the Osborn students as the "sink-or-swim" method. The student did his own planning; his choice of fields was his own. Acceptance or rejection of the method was up to the student himself. Harrison was patient with all of his

students as he watched for latent talents to manifest themselves. He recognized that not all could attain the brilliance of an S. R. Detwiler or the mature deliberative thinking of an F. H. Swett. There were quite a few who could not survive the sink-or-swim method but resigned themselves to coddling, which even in Harrison's day was more prevalent than it should have been.

At the time of his retirement he could have said in retrospect that he had created biological experimental science at Yale. He had so advanced the standard of the institution that, where it had once produced only an occasional graduate student in anatomy and zoology, it now was recognized throughout the world as a source of leading anatomists and zoologists. Many from abroad came to study with Harrison.

Scientifically this period was truly a high point for biology. It marked Harrison's solution of the neuron outgrowth riddle which, in its influence on biological thinking, has had value equal to that of Einstein's theory of relativity, Galileo's telescope, or Planck's quantum theory in other fields. His adaptation to animal material of Sach's culture methods, modified according to the needs of the cells to be studied, focused all biological science upon the possibility of eliminating influencing organismic reactions.

Tissue culture had its origin in the discovery of a method which could be crucial in determining the correctness of the neuron theories. One theory claimed outgrowth from the central nervous system (His, Cajal), while the other claimed that the nerves existed in predetermined paths (Hensen). Harrison proved the correctness of the outgrowth theory. His method was simple. He took cells from the central nervous system (spinal cord) and placed them in hanging drops of lymph fluid withdrawn from the lymph heart of the frog. The neuron grew from the central cell body. This marked a turn in the philosophical import of the study of the part isolated from the whole.

It was thus that tissue culture got its start, and the possibilities which can be attained by it have not yet been exhausted. Practical applications are numerous. The method first applied by Alexis Carrel to the study of connective tissues has been followed by many others—Earl, Paul, Fell, and Enders—to the point where it is of primary consideration in certain elementary views of disease.

Harrison attacked the problem of asymmetry with the same critical keenness, unhampered by the restrictions that had accompanied our earlier attempts to study *situs inversus*. By using the limb or the ear, both of which normally show the asymmetry of the side upon which they develop, he was able to devise experiments through which their laterality could be controlled and the rules under which they operate could be described.

The limb shows a gradual determination, with a fixity of its three axes at different times. One of these is established before the limb has become superficially apparent while the others come slightly later in development.

These studies impressed Harrison with the similarity between the formation of a crystal lattice and that of an organic complex, since the spaced (in time) appearance of the axes simulated many of the chemical conditions found. He attempted to secure more unifying data by working with Astbury in studying frozen-dried preparations for their x-ray diffraction pattern at different axial stages. This study, unfortunately, proved inconclusive.

Harrison was a gentle man who could readily admit mistakes in judgment. He stated, and frequently, "Each day is a day of discrimination, a period of judgment which must be passed on acquaintances, friends and colleagues. I hope that I have answered objectively and critically without being swayed by my personal feelings."

In the era of biology which included Morgan, Conklin, Wilson, Parker, Lillie, and Child, Harrison stood out as an individualist who pursued his research while doing other important things. As a department administrator he handled all affairs with a minimum of red tape. As managing editor of the *Journal of Experimental Zoology* he set the standards of scientific excellence which he demanded of all contributors. After his retirement he entered the field of administration as chairman of the National Research Council, where he was admired for his complete objectivity. He handled, during World War II, the increasing responsibilities for the national government with which the National Academy and the National Research Council were faced. His decisions, supported by Frank B. Jewett, president of the National Academy, formed the basis of some of our national policy in the critical days of atomic development.

Harrison was a perfectionist, and those of us who knew him best knew that his very human tendency to procrastinate was due to his weighing of all possible relevant evidence. As many of his admirers have stated, his passing marks the end of an era characterized by the dominance of a willingness to serve others, to judge fairly and without prejudice, and above all to seek both the truth and an accurate expression of its meaning.

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Science in the News

Peace Agency Bill Is Based on Democratic Science Group Statement: Mercury and U.S. Prestige Discussed

Efforts of the new Advisory Committee on Science and Technology of the Democratic Advisory Council have already borne legislative fruit, for on 6 January a bill (H.R. 9305) "to create and prescribe the functions of a National Peace Agency" was introduced in the House by Charles E. Bennett (D-Fla.). The bill, which has gone to the Foreign Relations Committee, embodies proposals contained in a committee statement that was released in early December as Advisory Council policy.

Eleanor Roosevelt summarized the purposes of H.R. 9305, known as the National Peace Agency Act, when she quoted from it as follows, as reported in the Chicago *Sun-Times* of 26 January: "It is the purpose of this act to deal with problems related to achieving peace through arms limitation agreements, to developing international control and inspection systems to enforce such agreements, and to applying scientific and technical resources to promote peace by eliminating or reducing the economic causes of war." She endorsed the bill by commenting that it was worthy of study by all those interested in "safe disarmament."

Representative Bennett describes his proposal as a "searching bill," one that would launch studies which would find the mechanisms for peace. He says: "We don't have a Utopian idea that this is going to end all wars, but even if just a little comes out of it, it can't help but be good." He feels that if this country spends so much money on wars, it ought to spend some on peace.

Science Committee's Statement

This thesis was strongly presented in the Democratic Science Committee's original statement, which points out that while the national defense budget is more than $44 billion, there is no substantial separate appropriation "for meeting the peace needs of our time." The report lists the few, small governmental groups, chiefly temporary, that are dealing with disarmament—including international agreements for arms limitation and nuclear-test suspension—and comments:

"The present government machinery for peace consists of the part-time efforts of a small number of people and the full-time efforts of a handful of experts.

"While the government has long understood the need to generate special organizations to resolve the problems of defense, it has not yet generated a single special organization to explore the problems of peace."

The committee warns that agreements on the limitation of nuclear tests and the production of nuclear weapons are urgent while the "nuclear club" is still small; that France will soon be a nuclear power; and that Communist China, and perhaps a dozen other countries, may not be far behind. The statement says: "Time is running out. It is absolutely vital that we organize our best thinking and processes of government so that our science and technology can be applied with all of its resourcefulness and ingenuity to devising solutions to . . . the maintenance of peace."

The committee statement also gives major attention to underdeveloped countries, pointing out that it is not enough "to apply organized scientific resources to neutralizing the military forces of war. We must also strive to capitalize these resources . . . by organizing to apply them to new positive programs for improving the economic lot of the underdeveloped nations of the world."

As conceived by the committee, the new agency would have a $1-billion budget and a program that is comparable in scale to that of the National Aeronautics and Space Administration.

Space Program Evaluation

The Democratic committee of 17 scientists was organized last spring under the chairmanship of Ernest C. Pollard, head of the department of biophysics at Yale University. Since that time it has analyzed a number of critical areas in which it believes scientific advice is important to national objectives. In addition to the peace agency proposal, the committee has issued a statement describing the relation of science and technology to our foreign and military policy, a statement on nuclear test suspension, and a statement on science and politics.

At present the committee is working on an evaluation of the space program and its objectives. In this connection, there was a meeting on 24 January at Democratic Advisory Council headquarters in Washington. A mid-day press conference opened vigorously because a 25-page committee working paper that was sharply critical of the United States space efforts had somehow reached the Baltimore *Sun*. The *Sun* article conveyed the mistaken impression that the committee was suggesting that the government delay Project Mercury, the NASA man-in-space program.

Pollard said emphatically that the report quoted in the *Sun* contained "anything but" the final thinking of the committee. He explained that committee working papers are prepared by only a few members and that they are especially designed to be challenging and therefore contain as many points of controversy as possible, including statements that are deliberate "jabs" to stimulate the committee members and keep them alert.

Mercury Another Vanguard?

Of Project Mercury, Pollard said that the committee feels that announcing Mercury prematurely and with such emphasis repeats the Project Vanguard procedure and unnecessarily jeopardizes national prestige. (Project Vanguard was the Navy's much publicized and often unsuccessful satellite program for the International Geophysical Year.) Above all, the committee objects to Project Mercury's being committed to a specific time schedule. The proposed launching should be carried out only when the "*right* time comes and we are ready," Pollard said.

When a reporter observed that Congress and others insist on target dates, Pollard replied: "What is your target date for curing cancer?" To amplify, Nobel laureate Polykarp Kusch of Columbia University commented: "There is a certain rate at which technological progress moves. No amount of money changes that."

Trevor Gardner, former assistant secretary of the Air Force for research and development, then suggested de-emphasizing Mercury and giving higher priority to "more reasonable programs, doable things on which target dates are feasible," such as the development of a communications satellite, a weather satellite, an international television satellite, and—"if we want to dream a bit" —a postal satellite. Kusch added: "We want to propose a challenge in an area in which we are likely to win, rather than taking up the Soviet challenges."

In closing, Pollard said that there was only a minority feeling in the group that the space program as a whole might be de-emphasized. There was unanimous agreement that this country is committed to an international space race "whether it likes it or not," and that therefore the entire program should be "overhauled" and speeded up. There was a suggestion that space-program problems are not only a matter of funding and that there should be "civilian management and thought, together with help from the military, like the Soviet system." A formal report on space is being prepared for release in the near future.

Science and Politics

Occasionally members of the Democratic Advisory Committee on Science and Technology emphasize their nonpolitical attitude toward work on the committee. For example, physicist vice chairman Richard B. Roberts of the Carnegie Institution of Washington said recently: "We are not trying to start a political controversy. What is important about the committee is that there is enough interest in what it has said to have launched legislation in the Congress."

The statement on "Science and Politics" that was released at the 24 January press conference expressed the following opinions:

"We feel that the citizen-scientist has a responsibility to think about the problems of science and society and to communicate his thoughts to those who can convert ideas into the fabric of national policy. . . .

"We are aware that we are breaking new ground in formalizing a relationship between science and politics. To those of us who are participating in this new venture, it appears that developments so revolutionary as the A-bomb, the H-bomb and the ICBM make it mandatory that new techniques in government . . . be tried."

Navy Craft Makes Record Descent to Ocean Floor

The Navy's bathyscaphe *Trieste* descended to the floor of the Marianas Trench in the Pacific Ocean on 23 January in a record dive of 37,800 feet, or more than 7 miles. This is probably the greatest ocean depth so far explored. The previous record depth was 36,198 feet, attained in August 1957 by the Russian ship *Vityaz*. The *Trieste* was piloted by Navy lieutenant Don Walsh of San Diego. He was accompanied by Swiss scientist Jacques Piccard who, with his father Auguste, designed and built the undersea craft.

The project was part of an oceanographic research program—Project Nekton, headed by Andrew Rechnitzer —that is being conducted by the Navy's Electronic Laboratory in San Diego and the Office of Naval Research in Washington. This was the third dive in a series that started in November to gather information about sunlight penetration, underwater visibility, natural underwater sounds, transmission of man-made sounds, water currents and temperatures, sea-floor configurations, and the effect of deep-water pressures on various mechanical devices. At full depth, the *Trieste*'s hull sustained a pressure of 16,883 pounds per square inch.

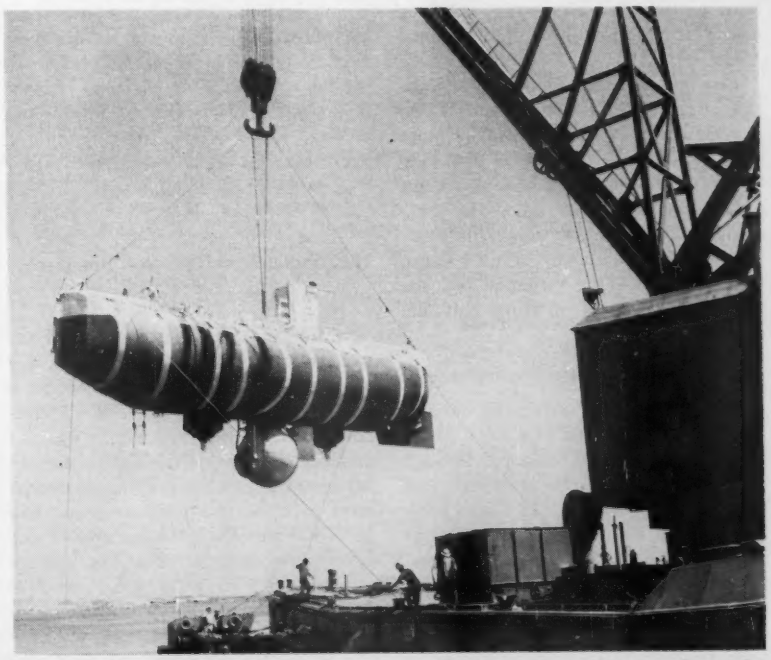
The vessel weighs 70 tons. A steel float that is 50 feet long and 11 feet deep provides buoyancy. Beneath this float is a 6½-foot, two-man cabin with two windows. The *Trieste* carries 10 tons of small iron pellets as ballast. To return to the surface, these shots are released at the rate of 1 ton for each 3000 feet of ascent.

Descent Described

The recent Marianas descent, which occurred approximately 250 miles southwest of Guam, took 4 hours and 48 minutes. The two men stayed on the bottom about 30 minutes, then began the trip to the surface, which took some 3 hours and 17 minutes. Both men emerged wet and shivering but were otherwise in good condition. Walsh made the following remarks about the trip:

"When the tube was flooded and we determined that the door was not leaking, we then ordered the ballast tanks flooded and the dive began. Unlike a submarine, the bathyscaphe *Trieste* is submerged by the topside crew on orders from the pilot in the sphere. This saves a great deal of weight in not having to install operating mechanism and additional wiring. . . .

"It stayed light outside until about 800 feet, when we saw our last bit of daylight. The trip to the bottom was long but uneventful; both Jacques and



The *Trieste* is lifted from the water by a crane. The sphere beneath the vessel contains a window from which pictures can be taken and undersea life observed.

myself were kept quite busy recording our data and piloting our inner-space craft.

"At around 6000 feet we began to feel the chill creeping into the sphere and we took a few minutes out to change into our heavy clothing. . . .

"We inched our way from 5500 down to 6300 fathoms, a distance of some 4800 feet. The bottom was touched as lightly as a feather, though we did stir up a cloud of mud when the sphere touched. After about 20 minutes of data-taking on the bottom, we released shot and headed for the surface."

Geological Survey Reports Accomplishments during 1959

Increased mapping activities, widespread investigations in geology and water resources, and new production highs from mineral and petroleum leases on public lands are described by the U.S. Geological Survey in its annual report for fiscal year 1959. During the year the survey marked its 80th anniversary (3 March 1959).

In topographic mapping, activities were carried on in every state, the District of Columbia, Puerto Rico, and the Virgin Islands. A total of 2439 maps were prepared for printing and distribution, of which more than 1600 constituted new mapping. A stock of some 30 million—about 21,000 different quadrangles—is available now, covering nearly half the total area of the United States.

Nearly 355 permanently marked triangulation stations were established to provide control for areas totaling more than 30,700 square miles. A new map of Tennessee was published, and maps of a number of other states are being compiled. Cooperative programs totaling $4 million were in effect in 34 states, Puerto Rico, and the Virgin Islands, the federal government meeting half the cost.

Research Appraises Resources

Survey geologists, continuing investigations and appraisals of United States geologic and mineral resources through comprehensive research programs, carried on approximately 425 active projects. Results of geologic investigations were reported in 27 professional papers, 65 bulletins, 91 maps, and 2 circulars published by the Geological Survey, in 43 reports released in open file, and in approximately 250 articles published in scientific journals.

New geophysical data about various areas of the country were provided through airborne radioactivity and magnetic surveys. Several new geologic, geophysical, and geochemical studies were directed toward the discovery of concealed ore deposits. Geologic mapping and stratigraphic studies designed to aid exploration programs in the mineral fuels field were in progress in 30 states, and Survey scientists participated in a special study of the nation's productive capacity of petroleum through 1975.

Water-resources investigations included the systematic collection, analysis, interpretation, and publication of hydrologic and related geologic data. Stream-flow data were obtained from about 7100 gaging stations. Some 640 ground-water investigations were in progress, and sediment and chemical quality studies were being made throughout the country, covering the most important river basins and groundwater aquifers.

Survey conservation activities were aimed at assuring proper development and use of water and mineral resources on federally controlled lands. This work required field surveys; preparation of maps and reports dealing with water power, fuels, minerals, and chemicals; and on-site supervision of mining and drilling operations.

Approximately 33,623 cases concerned with mineral classification were handled; 400 miles of stream-channel surveys and nine dam-site surveys were investigated; the operation of 4018 mining properties, in 34 states, and of about 151,000 oil and gas properties was supervised. Yields from the oil and gas properties were appreciably higher than in the previous fiscal year.

Hospitalization Rate for Persons over 60 Years of Age

More men than women at age 60 and over go to the hospital, but the men stay a shorter time than the women, it is reported by statisticians of the Metropolitan Life Insurance Company. Experience among Metropolitan's personnel indicates that the hospital admission rates in 1957 and 1958 averaged 156 per 1000 annually for men and 98 per 1000 for women. However, the average stay was 16.8 days for men, and 27.8 days for women.

The group under study, all aged 60 and over, included office and field personnel at work, on disability pensions, or retired. The statisticians point out that these persons are protected under a liberal hospitalization insurance program. The yearly hospitalization rate among males rose from 159 per 1000 at ages 60 to 64 to 185 per 1000 at age 75 and over. In each age group more men were hospitalized for nonsurgical than for surgical conditions. The two types of cases were about even for women.

The duration of hospitalization per case increased steadily with advance in age among both men and women, and for surgical as well as for nonsurgical conditions. Among males, the average stay per case for all causes combined increased from 13.3 days at ages 60 to 64 to 24.6 days at age 75 and over. Among the women, the average rose correspondingly from 16.3 to 37.5 days.

Among males, abdominal and urologic operations accounting for nearly three-fifths of the surgical cases. Heart disease accounted for one-third of the nonsurgical cases. Ranking next in order of frequency were digestive disorders, respiratory conditions, circulatory conditions other than heart, and diseases of the central nervous system. In general, the pattern of hospitalization for women resembled that for men, with abdominal operations the leading type of surgical condition and heart disease the most frequent cause of hospitalization for nonsurgical conditions.

AAAS Laurentian Hormone Conference

The 1960 Laurentian Hormone Conference of the AAAS will be held at Mont Tremblant Lodge, Mont Tremblant, Quebec, 4–9 September. Investigators interested in attending this conference should make application to the Committee on Arrangements of the Laurentian Hormone Conference, 222 Maple Ave., Shrewsbury, Mass., at as early a date as possible and in any event no later than 13 May. The conference rate is $14 per day per person. Since the number of participants is necessarily limited by available accommodations, all applicants are screened; invitations to attend are issued by the second week in June.

The meeting is divided into five sections—on testes function, hormones and reproduction, aldosterone, hormones and electrolyte metabolism, and hormones and organic metabolism. The program includes work by the following investigators from Canadian and European institutions: H. Nowakowski and

W. Lenz, Univ.-Klinik und Poliklinik, Hamburg-Eppendorf, Germany; Robert L. Noble, University of Western Ontario, London, Canada; E. Diczfalusy and Carl Gemzell, Karolinska Institutet, Stockholm, Sweden; Jean Bertrand, Hôpital Edouard Herriot, Lyon, France; Claude J. P. Giroud, Montreal Children's Hospital, Montreal; Norman Kalant, Jewish General Hospital, Montreal; R. H. Despointes and D. Das Gupta, Montreal Children's Hospital.

News Briefs

Biophysics placement service. The fourth annual meeting of the Biophysical Society will be held at the Sheraton Hotel, Philadelphia, Pa., 24–26 February. A new feature will be the institution of a placement service. This service will be available to registrants free of charge. Rooms for interviews will be available. Further information and forms for registration by prospective employers and candidates prior to the meetings may be obtained by writing to: Irving Gray, 3504 Preston Court, Chevy Chase, Md.

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Seamount. A submerged "island," which probably existed as a true island 8000 to 10,000 years ago, has been discovered in the South Atlantic, 550 miles west of the Cape of Good Hope, by Columbia University scientists aboard the university's research vessel *Vema*. The formation, a geological seamount, rises 15,980 feet from the ocean floor, higher than any peak in the United States, except in Alaska. Its top, in the form of a circular platform, is 210 feet below the surface of the ocean; one isolated knob rises to within 120 feet of the surface. The formation is about 35 miles across at the base and about 5 miles across at the top.

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Computers. The Denver Research Institute of the University of Denver will hold a Symposium on Computers and Data Processing at the Stanley Hotel in Estes Park, Colo., 28–29 July. The continuing theme of this series of meetings is the advanced treatment of basic problems in computer technology. Papers will be presented in the fields of components and devices, logic design, and philosophy of computer design. Although the program will be comprised largely of invited papers, a limited number of others will be selected for presentation. Authors who wish to submit papers should send abstracts of approximately 150 words, no later than *1 April* to: W. H. Eichelberger, Denver Research Institute, University of Denver, Denver 10, Colo.

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Draft deferment. A leaflet entitled "Critical Personnel and the Draft" has been prepared by the Scientific Manpower Commission (1507 M St., NW, Washington 5, D.C.). In the spring of 1959 Congress extended the draft act by 4 years, but with the knowledge that administration of the act by the Selective Service System is more liberal than it was previously with respect to the deferment of critical personnel. Among the latter are students and teachers of science, mathematics, and engineering and research workers and professionals in these fields. Queries about the operation of the law have been so numerous that the Manpower Commission has released the leaflet to help employers and Selective Service registrants.

* * *

Radioisotopes. An international symposium on radioisotopes in the biosphere was held recently at the University of Minnesota under the sponsorship of the Atomic Energy Commission, the National Science Foundation, and the Agricultural Research Service of the Department of Agriculture. Proceedings will be published by the University of Minnesota at cost. The hard-cover volume may be obtained at a prepublication price of $6.50. Orders must reach the Center for Continuation Study at the university (Minneapolis 14, Minn.) before 1 April.

* * *

Atomic energy meetings. The Atomic Energy Commission has published a 29-page catalog, *Proceedings of Technical Meetings*, which is available, without charge, from the commission's Technical Information Service Extension, P.O. Box E, Oak Ridge, Tenn. The catalog lists and describes the published proceedings of 126 selected meetings, conferences, and symposia held during the past 10 years and sponsored, cosponsored, or participated in by the commission or its contractors. Information on the availability and price of the *Proceedings* for each of the meetings is also given.

* * *

Soviet spectroscopy. The Optical Society of America has recently undertaken the translation and publication of the Russian journal *Optika i Spektroscopiya*, with the help of a grant from the National Science Foundation. This translation journal is being distributed free to all OSA members; it is also available to nonmembers on subscribing to the *Journal of the Optical Society*, at $25 per year. For nonmember subscriptions, write to the American Institute of Physics, 335 E. 45 St., New York 17, N.Y.

* * *

Chemical Society division. The American Chemical Society has announced the establishment of a Division of Public, Professional, and Member Relations at ACS headquarters in Washington. James H. Stack, managing editor of the ACS News Service, has been appointed director of the new division. Roy Avery, assistant managing editor of the News Service, becomes managing editor. The News Service has been made a part of the new division but will remain in New York.

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Biological handbooks. The Federation of American Societies for Experimental Biology, Washington, D.C., has been awarded a 2-year grant by the National Science Foundation for partial support of the Office of Biological Handbooks, which is operating at the federation headquarters under the direction of Philip L. Altman. Other agencies supporting the Office of Biological Handbooks are the National Institutes of Health and the Department of the Air Force.

* * *

Dental journal. A new journal, *Dental Progress*, to be published by the University of Chicago Press, will seek to bridge the gap between the researcher and the clinician. The Institute of Dental Research of the U.S. Public Health Service has made a 5-year grant of $137,000 to the University of Chicago to finance the undertaking. Rollin D. Hemens of the University of Chicago is executive editor, and George W. Teuscher, dean of the Northwestern University Dental School, has been selected as editor.

* * *

Mathematics. The Society for Industrial and Applied Mathematics has announced the first issue of volume 4 of *Theory of Probability and Its Applications*. This is a complete translation into English of the corresponding issue of the Russian quarterly journal *Teoriya Veroyatnostei i ee Primeneniya*. During 1960 the society will publish separate translations of all four issues of volume 4 (1959), will begin the translation of volume 5, and will publish in bound form full translations of volumes 1 (1956), 2 (1957), and 3 (1958). It is expected that by early

1961 translations will be appearing within 4 months of publication of the Russian original. Inquiries may be addressed to the society at Box 7541, Philadelphia 1, Pa.

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Radio telescopes. A temporary Advisory Panel on Radio Telescopes has been appointed by the National Science Foundation. The purpose of the panel, which is under the chairmanship of J. R. Pierce of the Bell Telephone Laboratories, is to (i) study the present and predictable needs of radio astronomers with regard to improved instrumentation; (ii) study the capabilities of existing and proposed instruments; and (iii) advise the foundation with regard to the desirability and feasibility of constructing more powerful instruments. Scientists and engineers wishing to bring their ideas to the attention of the panel are encouraged to communicate them to the Astronomy Program, National Science Foundation, Washington 25, D.C.

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Boulder meeting. More than 1000 people will visit Boulder, Colo., during 1960 to attend two national scientific conferences for which the National Bureau of Standards will serve as host. First of the two meetings will be the 1960 Conference on Standards and Electronic Measurements, to be held 22–24 June. This will be followed (12–14 December) by a combined meeting of U.S. members of the International Scientific Radio Union and the Institute of Radio Engineers.

W. D. George, acting chief of the NBS Radio Standards Division, is co-chairman of the standards conference, and Alan Shapley, assistant chief of the NBS Radio Propagation Physics Division, is in charge of local planning for the December conference.

Grants, Fellowships, and Awards

Allergy. The Scientific and Educational Council of the Allergy Foundation of America has announced that a limited number of quarterly or summer scholarships are available to second- and third-year medical students in the United States and Canada. These $600 scholarships are for a minimum of 8 weeks of work, during which the student will receive training and experience in both clinical and research allergy. Each medical school has been invited to submit the name of one applicant through the dean's office. All applications must be sent before *1 March* to Dr. Robert A. Cooke, Chairman, Scientific and Educational Council, Allergy Foundation of America, 801 2nd Ave., New York 17, N.Y.

Heart disease reporting. Entries are now being received by the American Heart Association in its eighth annual competition for the Howard W. Blakeslee Awards for outstanding reporting in the field of heart and blood-vessel diseases. The contest year, which began last March, will come to a close on 29 February. Newspaper and magazine articles, books, radio and television programs, and films published or produced during that period will be eligible. Deadline for submission of entries is *1 May*.

The winning entries and the number of awards will be determined by the association's Blakeslee Awards Committee. The awards carry an honorarium of $500 each.

Entries submitted by local daily or weekly newspapers and local radio and television stations will be considered apart from entries submitted by national wire services, syndicates, or radio–TV networks and will be eligible for awards in separate categories. Entry blanks and rules folders may be obtained from local Heart Association offices or from the American Heart Association, 44 E. 23 St., New York 10, N.Y.

Medicine. The Association of American Medical Colleges, with the aid of a $180,000 grant from the Smith Kline and French Pharmaceutical Company, has established a program to provide foreign fellowships through which students of United States medical colleges may travel abroad for a limited period of time to work in remote areas of the world. Any student who has completed his third year of medical school is eligible to apply for a fellowship. If accepted, he may spend 12 weeks or more at a foreign mission or other remote private medical facility, or at a public health unit, clinic, or hospital.

Cash awards will be made on an individual basis. A contribution to the expenses of the wife or husband accompanying the fellow will be made when this seems desirable. No awards will be made for the expenses of dependent children. Medical students who wish to apply for a fellowship must submit their application to the dean of their medical school.

Monograph prizes. The American Academy of Arts and Sciences has announced a 1960 Monograph Prize Program. These prizes are intended to encourage and assist the publication of scholarly contributions to knowledge that are too long for publication as articles in the professional journals and too specialized or too short to be published in book form. In response to the announcement of this prize competition that was made nearly a year ago, more than 500 manuscripts were submitted by scholars and scientists from all parts of the English-speaking world. The great majority of the monographs were of high quality, and a considerable number of them, in addition to those awarded prizes and those selected for honorable mention, impressed the judges as being worthy of publication.

The deadline for receipt of manuscripts in the 1960 competition is *1 October*. For information, write to the Committee on Monograph Prizes, American Academy of Arts and Sciences, 280 Newton St., Boston 46, Mass.

SEATO. The Southeast Asia Treaty Organization has announced its research fellowship program for 1960–61. The aim of the SEATO program is to encourage study and research (preferably leading to publication) on such social, economic, political, cultural, scientific, and educational problems as give insight into the present needs and future development of Southeast Asia and the Southwest Pacific, viewed against a background of SEATO objectives. A limited number of advanced research fellowships is offered for 1960–61 to candidates from member states (Australia, France, New Zealand, Pakistan, the Philippines, Thailand, the United Kingdom, and the United States). A candidate must be a national of a member state and should plan to undertake his research in SEATO countries situated within the treaty area. The applicant's project should be of interest to SEATO and, preferably, to two or more member countries, rather than to a single one, but it should not involve extensive travel.

Grants are intended for well-established scholars. A grant will provide a monthly allowance of $400 and will cover tourist-class round-trip air passage to the country or countries of research. Grants may be authorized for periods of from 4 to 10 months. Application forms and additional information may be obtained from: Conference Board of Associated Research Councils, Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D.C. Applications should be submitted no later than *1 March*.

Scientists in the News

Benjamin Lax, head of the solid-state division of Massachusetts Institute of Technology's Lincoln Laboratory, received the $1000 Oliver E. Buckley solid-state physics prize for 1960 at the annual dinner of the American Physical Society and the American Association of Physics Teachers on 29 January. He was chosen for his contributions to microwave and infrared spectroscopy of semiconductors.

The Institute of the Aeronautical Sciences presented the following awards at the annual Honors Night dinner on 26 January.

James A. Van Allen, head of the department of physics and astronomy at the State University of Iowa, received the Hill Space Award for discovering the radiation belts above the earth.

Brig. Gen. Don D. Flickinger of the Air Force Medical Corps received the John Jeffries Award for medical research in aeronautics.

Herbert Riehl, associate professor of meteorology at the University of Chicago, won the Robert M. Losey Award for his work on tropical weather phenomena.

Karel J. Bossart, of Convair, received the Sylvanus Albert Reed Award for his work on the Atlas ICBM.

James E. McCune, senior scientist of Aeronautical Research Associates of Princeton, won the Lawrence Sperry Award, honoring a representative young man in the field.

Jean Hanson, staff member of the Biophysics Research Unit of the Medical Research Council, London, England, arrived from the United Kingdom on 23 January, to visit this country until the end of March. Her itinerary includes New York, Pittsburgh, Boston, Washington, D.C., Philadelphia, Denver, Salt Lake City, San Francisco, and Los Angeles.

Paul F. Russell, who recently retired from the Rockefeller Foundation staff, has been appointed visiting professor of tropical public health at the Harvard School of Public Health.

William A. Owens, former professor and head of the department of psychology at Iowa State University, has become co-director of the Occupational Research Center of the psychology department at Purdue University. **Wilbur L. Layton**, formerly on the faculty of the University of Minnesota, has succeeded Owens at Iowa State.

Roy W. Wampler has resigned as director of research of the Libbey-Owens-Ford Glass Co., Toledo, Ohio, after 30 years with the company. Prior to retirement he will serve as a company research consultant. He graduated from McPherson College, took his master of science degree at Kansas State College and his doctorate in chemistry at the University of Chicago. His work with the company on multiple glazing units led to the perfecting of Thermopane. **Donald R. Martin**, director of high-energy fuels research for Olin Mathieson Chemical Corp., has succeeded him.

Fairfield Osborn has received the Medal of the City of New York in recognition of his 20 years as president of the New York Zoological Society. He plans to tour Africa to survey wildlife in British East Africa and the Belgian Congo.

The Arctic Institute of North America has selected **John Reed** as executive director, to succeed **A. T. Belcher** in April. Reed will resign as staff coordinator of the U.S. Geological Survey to take over his duties in the Montreal office of the institute.

Nicholas E. Golovin, former director of the technical operations division of the Advanced Research Projects Agency, has been appointed deputy to the associate administrator of the National Aeronautics and Space Administration.

Valy Menkin, former guest investigator at the Henry Phipps Institute of the University of Pennsylvania, has been named professor of pathology and chairman of the department at the School of Dentistry of the University of Kansas City. He recently received medals from the Pasteur Institute and the University of Liége.

Marie Boas, associate professor in the school of medicine of the University of California, Los Angeles, received the first Pfizer Award presented by the History of Science Society for her book, *Robert Boyle and Seventeenth Century Chemistry*.

Willard Bascom, technical director for the AMSOC Committee of the National Academy of Sciences, has been named distinguished lecturer for 1959–60 by the Society of Exploration Geophysicists. The committee is concerned with drilling a hole through the crust of the earth beneath the deep ocean.

Frederick Y. Wiselogle, associate director in charge of chemical research for the Squibb Institute for Medical Research, is president-elect for 1960 of the New York Academy of Sciences.

Recent Deaths

Sidney F. Blake, Arlington, Va.; 67; senior botanist and taxonomist for the Agricultural Research Service of the U.S. Department of Agriculture; authority on the Compositae; 31 Dec.

Wyndham Blanton, Richmond, Va.; 69; writer and specialist in internal medicine; professor emeritus of the Medical College of Virginia; contributing editor to the *Journal of the History of Medicine and Allied Sciences*; 5 Jan.

Edward M. Bragg, Ann Arbor, Mich.; 85; professor emeritus of the University of Michigan College of Engineering; head of the department of naval architecture and marine engineering until his retirement in 1944; 7 Jan.

George E. Haynes, Brooklyn, N.Y.; 79; sociologist, lecturer, teacher, and organizer in the field of Negro-white relations; instructor at the City College of New York until November 1958; 8 Jan.

Maximilian E. Jutte, East Meadow, N.Y.; 84; specialist in digestive ailments; deviser of duodenal and gastric irrigation equipment; former lecturer at New York Polyclinic Medical School; 14 Jan.

Leo Loeb, Clayton, Mo.; 90; professor emeritus of pathology at Washington University Medical School and head of the department until his retirement in 1937; became director of pathology at Barnard Free Skin and Cancer Hospital in 1910; former president of the American Association of Pathologists and Bacteriologists and the American Association for Cancer Research, Inc.; 28 Dec.

Margaret R. McMillan, Baton Rouge, La.; 38; biology professor at Louisiana State University; 9 Jan.

Emilio Viale, Wilmington, Del.; 38; entomologist; head of field development work for the agricultural chemistry division of the Hercules Powder Co.; 23 Dec.

Book Reviews

Planning for Freedom. The public law of American capitalism. Eugene V. Rostow. Yale University Press, New Haven, Conn., 1959. xi + 437 pp. $6.

Both the title and the subtitle of this book are significant. *Planning for Freedom* epitomizes the author's message that planning is not a monopoly of communists and socialists but has its place in an economy of private enterprise. Or rather, an economy of private enterprise *requires* government planning, for otherwise the "balance wheel" would be lacking in the capitalistic economy. Specifically, the planning has to see to it that the aggregate of all spending in the economy is high enough to ensure full employment but not so high that it produces inflation. The primary instruments of this planning effort are monetary and fiscal policy. In order to be effective, these instruments must be supplemented by policies designed to maintain free competition or to regulate markets where monopolies are inevitable. Rostow offers a very readable explanation of the "new economics" as it was developed along Keynesian lines of reasoning. He surveys the experience of the 1930 depression and the post-World War II recessions in the light of these theories, and he sketches what he believes remains to be done to assure a continued economic growth with full employment and without inflation. This statement of the "new economics" differs from other presentations in that it is nontechnical but avoids overpopularization. It can be highly recommended to the interested layman.

The work also differs from others by the aspect expressed in its subtitle. Rostow, dean of the Yale Law School, emphasizes the "public law" through which the "new economics" is institutionalized in the United States. That system of law consists of three major elements; the laws governing fiscal and monetary policy, the laws regulating the markets for products and services, and the labor law. "These three pre-existing bodies of law . . . are being drawn together into a new field of magnetic force by the influence of the Employment Act of 1946, which is giving them new dimensions, and new orientation, and a new momentum" (page 368).

This treatment of the institutionalization of the new economics represents an interesting emphasis which is, as far as I know, much less familiar in the United States than it is in Continental Europe, where "public law" is an established discipline within the broad field of jurisprudence. I would not be surprised if Rostow's book, and particularly the interesting methodological chapter, "The goals of legal action," should give rise to a controversy as to whether this topic can better be approached with the tools and concepts of political or those of legal science. Actually Rostow incorporates in his concept of public law realistic rules which in some cases are not only not incorporated into laws but may even run counter to conventional interpretation of existing laws. An example is his statement that "the normal rule . . . goes further to give the President and the Treasury something close to a veto over Federal Reserve policy" (page 175). While this statement has merits as a proposition of economic policy, it is questionable as a proposition related to existing law.

I find that in one respect the emphasis on the public law of the subtitle limits the author's interpretation of the main topic. Planning in a private enterprise economy is not only a function of government. It also requires that, for example, the investment and production planning of private enterprise is related to the public planning. Such a link between public and private planning can be created by establishing goals for the guidance of public policy, which then may also become voluntary landmarks for private enterprise planning of business and for wage strategy planning by labor unions. I regard the establishment of such goals through national economic budgets and national economic projections as essential tools of planning in a private enterprise system.

Rostow discusses the need to develop objectives, particularly in an excellent chapter, "The economic claim of foreign policy," but he does not recognize the need of translating national and international objectives into quantitative and internally consistent targets as a prerequisite of public and private planning.

Rostow's book has a thoroughly optimistic tone. He believes that with proper fiscal and monetary policies, supported by antimonopoly measures, the main economic problems can be solved. Only in the field of international monetary relations does he see danger of the possibility that holdings in one particular currency (for example in dollars or pounds) can be converted into gold, which would "destroy the world's banking system" and would "lead either to a general financial crash or to a new wave of planned or unplanned devaluations" (page 204).

But I believe that Rostow is overly optimistic with respect to the capabilities of fiscal and monetary policy not only to promote full employment and economic growth but also (and at the same time!) to prevent "creeping" inflation. I believe more institutional innovations may be needed than are suggested by Rostow, particularly in the field of wage determination and collective bargaining.

Rostow is optimistic also in his belief that American society is not in danger of becoming overly complacent in an age of abundance. In contrast to the many current expressions of a pessimistic mood, Rostow believes that "the years of boom have been invigorating and creative, not stultifying" (page 384) and that the task of perfecting a new economic system of freedom is not boring but "interesting enough" (page 377).

The economic system which he sees emerging is neither capitalism of the laissez-faire variety nor socialism, concerning which Rostow quotes the saying: "Capitalism is the exploitation of man by man, Socialism the reverse" (page 378).

GERHARD COLM
National Planning Association, Washington, D.C.

Gregor Mendel und das Schicksal seiner Vererbungsgesetze. vol. 22, *Grosse Naturforscher*. Ingo Krumbiegel. Wissenschaftliche Verlagsgesellschaft, Stuttgart, Germany, 1957. 144 pp. Illus. DM. 10.80.

Among the truly great figures of the 19th century, Gregor Mendel will always remain a half-revealed, somewhat enigmatic personality. So little has been preserved for us about him—especially so little relating to his scientific work and achievement. Almost everything known or conjecturable about Mendel, priest and scientist, was put into the classic biography by Iltis (1924). To this Krumbiegel has added just a little that is new, in an appreciation that covers with respect and admiration the years of childhood, teaching, genetic experimentation, and priestly administration.

In his effort to fill out the story, the author has supplied chapters on the historical background of research into the secrets of heredity, on the nature of Mendelian heredity, and on the relations of Mendel's work to that of other biologists, contemporary and later. Here Krumbiegel is not always accurate, particularly in the effort to discuss the chromosome theory of heredity, which in its inception was independent of Mendel's own way of thought and method of experimentation. The author overlooks the role of Linnaeus in beginning the studies of species hybridization in the 18th century; he is not fully informed about the relations between the three rediscoverers—Correns, de Vries, and Tschermak; he over-emphasizes, perhaps, the admittedly great role of Richard Goldschmidt in modern genetics, by overlooking completely other giants in the development of this 20th century science. He is at his best, on the other hand, in the chapters that deal with Mendel's personality, life, botanical work, and scientific activities outside botany—in meteorology and in his efforts to breed and study bees. In numerous places the author emphasizes Mendel's great interest in Charles Darwin's novel theory of evolution by means of natural selection, a theory which Mendel apparently accepted.

All in all, this modest volume is a very worthwhile addition to the far too few books about Mendel. For the English reader, it may also prove a good test of one's command of the German language, since it is written in a characteristic elevated style: "Gregor Mendel war ein Feuergeist, der der Welt gezeigt hat, dass man mit bescheidenen Mitteln unendlich Grosses leisten kann. Einige Tüten Pflanzensamen waren sein Werkzeug, sein Geist seine Waffe, mit der er einer Welt die Stirn geboten und gesiegt hat." Quite a tribute! Somehow I cannot avoid comparing it with the simplicity of Mendel's own way of expressing himself, which achieved a style combining utmost clarity with trenchant insight, as, for example, when he says of the queen bee, in a remark quoted in this volume: "Sie soll sich nun einen ordentlichen Mann aussuchen, denn es ist hier, wie bei den Menschen, traurig, wenn eine gute Frau einen schlechten Mann bekommt."

BENTLEY GLASS
Department of Biology,
Johns Hopkins University

Nature and Man's Fate. Garrett Hardin. Rinehart, New York, 1959. xi + 375 pp. Illus. + plates. $6.

Nature and Man's Fate is a book of many faces. It is one of the best accounts yet written of the evolution of the theory of evolution and, as such, reflects the expenditure of much time and scholastic effort. Inevitably it is concerned more with genetics and selection than with the aspects of either nature or the fate of man. Genes, in fact, dominate the theme, and as a lively, vivid, and informative presentation for the general reader of the nature and importance of genes to the present and future well-being of man, Hardin's book is excellent and could hardly be better.

Obviously it has been a labor of love. The first third is mainly an account of the development of the theory of evolution, beginning with Erasmus Darwin—an account in which Charles himself emerges more fully as a complete personality than in any other I have seen. At the same time, the theory of natural selection is discussed both in relation to other concepts current in the 19th century and to present-day cybernetics, all in a most enlightening way. Any student of evolution, lay or professional, would profit from a reading of this section alone, not to mention the following part, which deals with Gregor Mendel and the rediscovery of genetics.

After his introduction to genetics by way of Mendel, Hardin discusses the role of eugenics and the general value of genetic information to human individuals everywhere, both in terms of personal problems and political doctrines. This part contains the only error of fact noted, which was in the reprinting (on page 163) of Scheinfeld's list of "Human Heredity Clinics," where McGill University is located in Toronto—a sin which is equivalent to placing Johns Hopkins University in Pittsburgh and which may account for the absence of inquiries made to the aforementioned clinic. More genuinely disturbing, however, is Hardin's rough treatment of H. J. Muller's past ideological unorthodoxy, included here in a historical account of Lysenko's unfortunate impact upon genetics and geneticists in Russia. Clear vision is of course to be coveted, but hindsight is so much easier to acquire than foresight that it would have been charitable to recognize this fact, particularly since Hardin was in his teens during the period in question.

The last section of the book, dealing with the possible future channels for human evolution, is the most challenging. This is especially true of the final chapter, "In praise of waste," which is a refreshing emphasis upon the primary value of human individuality in a progressively conformist world. Taken all together, with its pervading enthusiasm, its blunt criticism of people and mores, and its innately optimistic outlook toward the long-term future, *Nature and Man's Fate* is a book that every intellectually mature adult everywhere should read and reflect upon.

N. J. BERRILL
Department of Zoology,
McGill University

Classical Mechanics. J. W. Leech. Methuen, London; Wiley, New York, 1958. ix + 149 pp. Illus. $2.50.

In this brief monograph, Leech gives a broad general review of classical mechanics, which avoids many of the tedious details that so often mask essential ideas. The book is intended to assist the experimental physicist in building up a background for theoretical understanding of classical mechanics and

to stimulate the theorist to study more complete treatises on the subject. Directed at a suitable level for graduates of English normal honors physics courses, it could be read with profit by a senior or by a first-year graduate student at a good American university.

The volume covers many of the advanced topics of classical mechanics, including the Lagrangian formulation, the Hamiltonian formulation, variational principles, transformation theory, Poisson brackets, the study of continuous systems, relativistic mechanics, and fields. The author treats these topics in a straightforward fashion, hitting the highlights of a range of topics which are treated in considerably greater detail by Whittaker and by Goldstein in their classical treatises. In the final chapter on the Lagrangian and Hamiltonian background to field theories, the author confines himself to an outline guide to the subject. His purpose is to emphasize the wide generality of the methods of analytical mechanics, which are developed as an alternative to Newton's laws in describing the behavior of particles. He makes the point that the formulation of field theories is comparatively simple and elegant, although the detailed working-out of the field theories is a long and complicated process. These complexities are intentionally glossed over in an effort to display the essential structure.

While the book is primarily intended as an introductory work in classical mechanics, it could also be used well for review by physicists who have previously sweated through more detailed treatments of these same topics. One should never underestimate the joy of a person in reading or in hearing something that he already knows—or once knew.

ALEX E. S. GREEN
Physics Division, Convair, San Diego, California

Communist Economic Strategy: Soviet Growth and Capabilities. Alec Nove. National Planning Association, Washington, D.C., 1959. 82 pp. $2.25.

This little volume presents a generally reasonable and sound appraisal of the economic achievements and prospects of the Soviet bloc. It discusses the ideological forces motivating expansion, the resources underlying expansion, the organizational structure of the economy, the economic performance to date, and the prospects both for internal growth and for winning over uncommitted countries. The discussion is generally well balanced and lays before the reader some of the more important differences of opinion among specialists on the Soviet economy. It is, in brief, a praiseworthy book.

The study of Soviet economies is still in a primitive state because of the difficulties in getting a detailed and reliable picture of basic facts. Most questions of fact are still unsettled, let alone questions of interpretation. Hence, all specialists will find something in this book to quarrel about, and some will find more than others. This does not detract from the general excellence of the book. It merely reflects the poor state of the science—and the intensity of feelings on the subject.

It is natural that I have a complaint, since Nove considers and then explicitly rejects my estimate of the rate of Soviet industrial growth. His discussion, beginning on page 39, is to be commended for presenting representative and conflicting estimates of Western scholars. My estimate is dismissed on the ground that it is lower than the others, a seemingly reasonable ground if no other criteria are to be used. One would expect to find Nove also rejecting the highest estimate in his list—one made by Francis Seton of Oxford—as an extreme, but he does not do so. Instead, he accepts it as most probable.

Seton's estimate is based on growth trends for steel and energy alone, on the assumption that industrial growth has been related to steel and energy production in the Soviet Union in the same way that it has been in a number of Western countries over recent decades. There are several cogent reasons for believing that this comparison is invalid and that a more correct one—for instance, with the United States around the turn of the century—would yield a much lower estimate of Soviet growth. But this cannot be argued here. The point to be made is that Seton's estimate of Soviet industrial growth is based on inadequate evidence, which leaves me puzzled as to why Nove accepts it.

It may be appropriate to settle here one factual mistake made by Nove. To support Seton's estimate, he states that Soviet industrial output rose from one-ninth of the United States' level in 1913 to one-third in 1955. Nobody knows enough about recent levels of Soviet production to be able to speak with strong conviction on relative output in recent years. But the evidence is much more abundant for 1913, and there can be little doubt that Nove understates the relative Russian output in that year.

He cites two sources for his figure of one-ninth, the first being a recent work by the elder Soviet economist, Strumilin. Looking to the source, one finds Strumilin is less than certain about the precise fraction, and he gives a range of figures that can be derived in different ways. In recent testimony before the Joint Economic Committee, Allen Dulles interprets Strumilin as having decided on one-eighth as the best estimate, and this is the figure Deputy Premier Kozlov used in his parting speech in this country. One-eighth is significantly larger than one-ninth, and it seems certain, for reasons that cannot be explained here, that one-eighth is still too low.

The other cited source is a publication by the League of Nations. Looking there one finds, first, that the fraction shown is actually one-eighth, not one-ninth as Nove reports. Moreover, the estimate—described by the source as "necessarily rough"—was calculated for 1925–29 and projected backward to 1913 on the basis of production indexes for the two countries. This would not be too important were it not that the official Soviet index (for large-scale production only) was used for the Soviet Union. That index shows Soviet industrial output as increasing by 35 percent between 1913 and 1925–29, whereas in fact it did not increase at all but declined somewhat. Correcting for this alone would raise the estimate for 1913 to one-sixth instead of one-eighth. Using much more direct evidence, I have calculated that the correct fraction probably lies between one-sixth and one-seventh.

It is a pity that Nove did not tidy up this little statistical corner where error is not entirely forgivable. His other figures may all be more soundly based, but one's confidence is not full.

However serious these shortcomings might be, they are more than overcome by other virtues. The book is well worth the reading.

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Microbiology. Louis P. Gebhardt and Dean A. Anderson. Mosby, St. Louis, ed. 2, 1959. 476 pp. Illus. $5.75.

Principles of Microbiology. Walter W. Krueger and Karl R. Johansson. Saunders, Philadelphia, Pa., ed. 2, 1959. xxiv + 563 pp. Illus. $6.75.

Texbook of Microbiology. William Burrows. Saunders, Philadelphia, Pa., ed. 17, 1959. xxxiii + 954 pp. Illus. $14.

The titles of these books are to some extent misleading, for the books are not primarily concerned with microbiology as a general field, but rather with certain parts of it. Burrows and also Krueger and Johansson, for instance, consider microbiology to be the study of organisms closely involved in man's activities, and the treatment of Gebhardt and Anderson follows the same pattern. This point of view not only eliminates from microbiology the study of many of the more interesting bacteria, fungi, and protozoa but leaves us without a name to apply to the study of microbial forms of life generally. It must be admitted, however, that this loose use of the term *microbiology* is not restricted to these authors, for there is at present a very strong tendency to use *microbiology* rather indiscriminately, particularly as a substitute for *bacteriology*—a tendency which not only ignores the etymology of the terms but also abolishes any real distinction in meaning between them.

The second edition of *Microbiology*, by Gebhardt and Anderson, does not differ significantly from the first in the organization of the material, although several chapters have been rewritten and much new material has been added. The first third of the book is devoted to general topics in bacteriology and has been increased about one-third in this edition. The chapters on historical development, microbial genetics, antibiotics, and immunity have been rewritten and enlarged. The second section, dealing with applied microbiology, has been less extensively rewritten, and the final portion, which is concerned with infectious diseases, is but little changed.

This book was written for classes composed of students in nursing, home economics, pharmacy, or sanitary science. It requires no knowledge of other biological sciences or of chemistry and introduces relatively simple concepts in logical sequence. Wherever possible, the authors have tried to use a historical approach, and for the most part, they have succeeded. Indeed, *Microbiology* is outstanding among textbooks of elementary bacteriology in its use of historical material. It might be less than satisfactory for students majoring in some branches of biology, but for the audience for which it was written, it should serve as a satisfactory textbook to accompany lectures on elementary and applied bacteriology.

In the second edition of *Principles of Microbiology*, W. W. Krueger has been joined by Karl R. Johansson, as junior author. Students using this book will need some knowledge of chemistry to comprehend the chapters on the physiology of microorganisms, but no previous work in the biological sciences is required. The first part of this book, which deals with the general principles of bacteriology, is clearly and logically written; the only chapter which the average student might find difficult is that on heredity. The part dealing with the applications of microbiology is of the same high standard, adequately covering industry and agriculture as well as the fundamentals of food, water, and sewage bacteriology. The final part is a discussion of some of the more common infectious diseases of man. Primary emphasis is on the elementary epidemiological, pathological, and immunological aspects, but the microorganisms causing these diseases are dealt with cursorily. Consequently, this part drops below the level of excellence of the rest. Nevertheless, this textbook should serve excellently to introduce students to bacteriology (or microbiology) and might even be suitable as an introduction to the general subject of biology.

A new edition of *Textbook of Microbiology*, by Burrows, is always a notable event in the field of bacteriology, for this has been an outstanding text and reference book for more than 50 years. This edition, like many of its predecessors, is the result of much revision and extensive rewriting and has been brought up to date in most of the sections that have not been completely rewritten. As in the 16th edition, Burrows has had the collaboration of R. J. Porter and J. W. Moulder, who wrote the excellent chapters on parasitology and bacterial metabolism, respectively. About half of this book is devoted to the general principles of bacteriology and immunology, the other half to the agents of infectious disease. About as much space (250 pages) is given to the pathogenic bacteria as is given to the spirochetes, the parasites, the rickettsiae, the viruses, and the pathogenic fungi.

The few errors that I noticed were in the discussion of infectious agents more commonly associated with animals than with man. The paragraph on immunization against *Clostridium chauvoei* is about 40 years out of date; the section on *Pasteurella multocida* should be made current and should include some information on human infections. The work done on listeriosis during the last few years has not been considered, and consequently the importance of listeriosis as a disease of man is grossly underrated, the number of known cases being several hundred, rather than 20, as is stated. These are trifling errors, however, in a book which can be thoroughly recommended as the best textbook on the immunology and microbiology of infectious diseases of man published in the United States today.

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New Books

Jewish Medical Ethics. A comparative and historical study of the Jewish religious attitude to medicine and its practice. Immanuel Jakobovits. Philosophical Library, New York, 1959. 409 pp. $6.

Logical Positivism. A. J. Ayer. Free Press, Glencoe, Ill., 1959. 463 pp. $6.75.

Man's Great Future. Erwin D. Canham, Ed. Longmans, Green, New York, 1959. 204 pp. $4. Condensed from the 50th anniversary edition of *The Christian Science Monitor.*

Organic Chemistry. Donald J. Cram and George S. Hammond. McGraw-Hill, New York, 1959. 727 pp. $8.50.

Properties of Matter. F. C. Champion and N. Davy. Philosophical Library, New York, ed. 3, 1959. 350 pp. $10.

Recent Progress in Oxytocin Research. B. Berde. Thomas, Springfield, Ill., 1959. 119 pp. $4.75.

Second United Nations International Conference on the Peaceful Uses of Atomic Energy, Proceedings. vol. 14, *Nuclear Physics and Instrumentation*, 500 pp.; vol. 18, *Waste Treatment and Environmental Aspects of Atomic Energy*, 635 pp.; vol. 22, *Biological Effects of Radiation*, 562 pp. United Nations, New York, 1959.

A Textbook of Surgical Physiology. R. Ainslee Jamieson and Andrew W. Kay. Livingston, Edinburgh, Scotland; Williams and Wilkins, Baltimore, Md., 1959. 631 pp. $11.

Reports

Protein Spherulites

We have recently observed that the crystal habits of the enzyme carboxypeptidase (*1*) differ according to the protein concentration of the mother liquor. At low protein concentrations a branching, sheaflike crystal morphology is observed, a typical example of spherulitic crystal growth. At high protein concentration, the classical, polyhedral crystals appear. The dependence of crystal form on protein concentration adds another parameter for study of the crystallization of this and possibly of other proteins. The existence of spherulitic behavior, which has been well studied in a number of macromolecular model systems, may have new implications for the interpretation of the biophysical organization of crystalline proteins.

Carboxypeptidase is a zinc metalloenzyme (*2*) of molecular weight 34,300 (*3*), containing one atom of zinc per molecule of protein; even though it is firmly incorporated into the molecule it can be removed and restored with concomitant loss and restoration of function, but apparently without physical change in the molecule (*4*). The primary structure consists of a single polypeptide chain of 310 amino acid residues (*5*), hydrogen bonded to form the helical secondary structure, according to the presently accepted views of protein structure (*6*). The density of 1.33 and the globular shape, denoting close packing, may result from folding of the molecule (*6*). The protein has an isoelectric point at *p*H 6.0 and a net negative charge in the region of *p*H 8.0, where the crystallizations described here were carried out (*3*). Although it is soluble to the extent of 20 to 30 mg/ml in 1 *M* NaCl, it is highly insoluble in distilled water. It is this insoluble character of the protein which permits its crystallization at the low protein concentrations and which promotes spherulitic crystal growth.

Carboxypeptidase was prepared from beef-pancreas acetone powders (*7*) by the method proposed by Allan, Keller, and Neurath (*8*). The recrystallized protein was homogeneous, as was demonstrated by ultracentrifugation and electrophoresis. For crystallization, the protein was dissolved in 1*M* NaCl and dialyzed in Visking-Nojax dialysis bags (*9*) in a rotary dialyzer at 4°C against successively decreasing salt concentrations, buffered at *p*H 8.0 with 0.02*M* sodium veronal. The speed of agitation and the rate of decrease in salt concentration were identical in all experiments.

The various crystal habits of carboxypeptidase observed in this study are shown in Fig. 1, arranged in descending order of concentration of protein (in milligrams per milliliter) of the solution employed for crystallization. Figure 1*A* shows a large, polyhedral crystal, typical of those obtained at 30 mg/ml. At concentrations of 10 mg/ml, the classical, polyhedral crystals, shown in Fig. 1*B*, are seen. These crystals consistently appear at salt concentrations of from 0.3 to 0.5*M*. At protein concentrations of 5 mg/ml, a mixture of spherulitic sheaf crystals and of the classical polyhedral morphology appears (Fig. 1*C*). At a concentration of 2 mg/ml, spherulitic crystals are obtained exclusively (Fig 1*D*). Characteristically, these crystals exhibit a typical birefringent pattern, as shown in Fig. 1*E*, under crossed Nicol prisms. By means of a gypsum plate, the larger index of refraction was found to be oriented along the radius of the spherulite, a "positive" orientation as defined by convention (*10*). In contrast to the polyhedral form, these crystals appeared consistently at salt concentrations between 0.05 and 0.1*M*. The spherulitic and polyhedral crystals, when redissolved, can be interconverted by either diluting or concentrating the protein solution to the appropriate protein concentration.

Figure 2 demonstrates the morphological details of the spherulitic crystal growth shown in Fig. 1, *D* and *E*. Figure 2 demonstrates the aggregation of the fibrous subcomponents (Fig. 2*A*) into the incompletely assembled spherulite (Fig. 2*B*), and into a spherically symmetrical complete spherulite (Fig. 2*C*.). Figure 2*D* represents branching overgrowth of a spherulitic aggregate, and Fig. 2*E*, the morphological detail of this preparation, obtained from a solution of 1 mg of protein per milliliter. The complete spherulite in Fig. 2*C* is shown again in Fig. 2*F* as seen under crossed Nicol prisms and exhibiting the characteristic birefringent pattern.

In neither mode of crystallization did the presence or absence of zinc in carboxypeptidase affect the gross crystal morphology. With the native and the metal-free derivative of the enzyme, or with the enzymes reconstituted with Fe^{++}, Mn^{++}, Co^{++}, and Ni^{++}, virtually identical types of crystal habits are obtained. These metal ions have been shown to substitute for zinc in binding to the apocarboxypeptidase with concomitant restoration of function (*11*).

The phenomenon of spherulitic crystal growth has received increasing attention ever since the discovery that this is the normal mode of crystallization in a number of synthetic and natural polymers. Spherulites were first observed by Bunn and Alcock in synthetic polyethylene in 1945 (*12*) but are now known to occur in a variety of substances, including gutta-percha, natural rubber, sphingosine (*13*), polyethylene, polymethylene, polyamides, and polyurethane (*14*). Spherulites of carbonates, sulfur, and resorcinol have also been seen, though this is not a common mode of crystallization in such simple substances (*14*).

The gross morphology and fine structure of these crystals have been discussed extensively (*13–15*). The typical birefringent pattern, a bright sphere with a dark Maltese cross whose arms lie in the direction of the axes of polarizer and analyzer, is easily recognized in polymers crystallized from the melt. Extensive studies with light (*16*) and electron microscopy (*14*) have shown the underlying structure to be wheatlike sheaves of crystallites which approach a spherically symmetrical aggregate.

Thus, the spherulitic crystal form is the normal mode of crystallization in

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Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

these polymer systems. X-ray, electron diffraction, and birefringent patterns of polymers indicate that the molecules are helically wound, with the long axis of the helix along the radius of the fibrous crystallite (*14*). The spherulites of polyamides are consistently positive, and a tightly wound helix has been proposed as the model for the molecular orientation (*17*). The helix extends along the fiber axis in such a way that the long axis of the molecules is tangent to the fiber axis. Hydrogen bonding is thought to take place in planes parallel to the fiber radius.

In carboxypeptidase, the spherulitic form, analogous to that of polymers, has been observed only when the enzyme is crystallized from dilute solutions of protein. Electrostatic, covalent, and hydrogen bonds as well as weak van der Waal's forces are, of course, all known to contribute crucially to the configuration of polymers and proteins (*6*). It is not understood whether any one of these forces governs and dominates spherulitic fine structure or whether this is due to a critical balance between them.

It is well known that the environmental conditions (solvents, impurities, ionic strength, *p*H, and so on) under which crystallization takes place, alter the crystal habits of given enzymes—among other proteins—significantly (*18*). In addition, enzymes exhibiting specificity toward the same substrate but obtained from different biological species also vary markedly in gross crystal morphology (*18*). The concentration of protein in the solution in which crystallization occurs should be considered in assigning significance to observed differences in crystal forms. The significant effect of protein concentration on the crystal form of carboxypeptidase suggests that this parameter may also be responsible, in some instances, for variations in morphology currently attributed to other factors (*18*). The data reported here demonstrate conclusively that crystal morphology in this system can be reversibly altered, at will, from a spherulitic to a polyhedral form without detectable changes in enzymatic function.

It is characteristic that polymers, in crystallizing as spherulites, extend out along the long axis of the fibrous units for some distance. The appearance under crossed Nicol prisms is explained on the basis of spherically symmetrical aggregates of index ellipsoids, with the long axis either parallel or tangential to the spherulite radius (*10*). The packing and folding of the polypeptide chains of the individual protein molecules—greater than that of synthetic polymers—suggests that the protein molecules span a much shorter distance along the axis of the fibrous unit. It may be postulated that the respective axes of the protein molecules, corresponding to the larger index of refraction, line up parallel to the radius of the fiber and in colinear relationship to each other. In this manner the protein would achieve a spherulitic morphological pattern and consequent birefringent properties equivalent to those of the polymer crystal.

The implications of spherulitic morphology to fine structure of synthetic polymers may thus be extended to proteins. Therefore, inferences may be drawn concerning the orientation of the protein molecule in the crystal lattice. Carboxypeptidase may serve as a

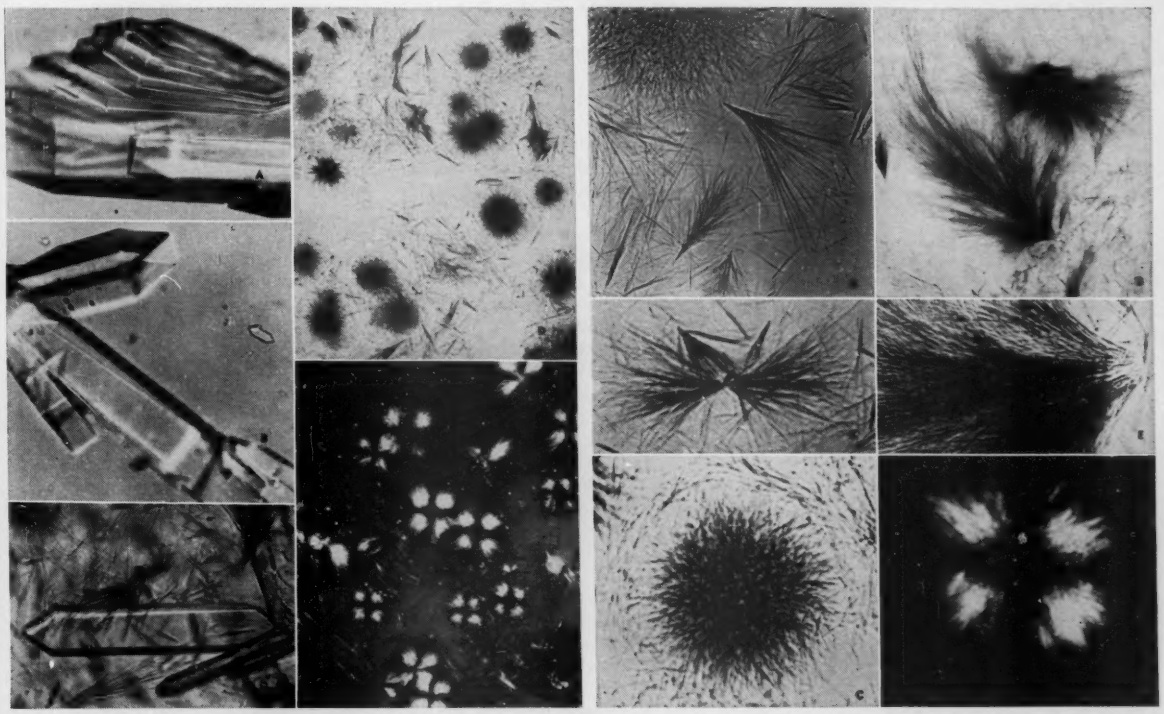

Fig. 1 (left). Crystal forms of carboxypeptidase. All concentrations given are in milligrams of protein per milliliter of mother liquor. (*A*) Large polyhedral crystal, 30 mg/ml (about × 25). (*B*) Classical, polyhedral crystals, 10 mg/ml (about × 50). (*C*) Combination of spherulites and polyhedral crystals, 5 mg/ml (about × 75). (*D*) Spherulites, 2 mg/ml (about × 50). (*E*) Appearance of preparation in *D* under crossed Nicol prisms (about × 50). Fig. 2 (right). Details of spherulitic crystal growth. (*A*) Small branched crystallites. (*B*) Partially assembled spherulite. (*C*) Spherically symmetrical, complete spherulite. (*D*) Hairy overgrowth occurring at a concentration of 1 mg of protein per milliliter. (*E*) Detail of *D*. (*F*) Appearance of complete spherulite in *C* under crossed Nicol prisms (about × 98).

prototype of a more general phenomenon in the mode of crystallization of proteins. This conjecture can be readily verified (*19*).

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16 September 1959

Virulence Transformation of a Trichomonad Protozoan

Abstract. Treatment of an avirulent strain of *Trichomonas gallinae* with a cell-free homogenate of a virulent strain resulted in enhanced virulence as evidenced by the size of lesions produced in mice. Addition of deoxyribonuclease to the homogenate cell mixture blocked the transformation.

Marked differences in virulence in strains of *Trichomonas gallinae*, a flagellate parasite of columbiform and galliform birds, can be demonstrated readily in natural hosts (*1*) and in laboratory mice (*2*). It seemed feasible to determine whether transformation of the virulence of a relatively nonpathogenic strain to enhanced virulence might be accomplished by treating the cells with cell-free material from a highly pathogenic strain, although, as far as can be ascertained, such transformation of protozoans has not been reported previously.

Differences in pathogenicity among strains of *T. gallinae* from axenic cultures can be evaluated quantitatively by comparison of the mean volumes of 5-to-6 and 12-to-14 day lesions produced in mice by subcutaneous flank inoculation of 7.5 to 9.0 $\times$ 10^5 parasites in 0.5 ml of medium (*3*). This assay for virulence was employed in the present investigation.

Two strains of *T. gallinae* were used: the very pathogenic Jones' Barn strain (JB), isolated in axenic culture from a liver abscess of a pigeon in the summer of 1958, and the relatively nonpathogenic Lahore strain (YG), isolated in a similar culture from the mouth of an apparently healthy pigeon in the early fall of 1956. Both experimentally infected birds came from Robert Stabler. It must be noted that in the long series of transfers on fluid thioglycollate (FT) with 1 or 5 percent normal horse serum (FTS), YG strain has become further attenuated in pathogenicity and will be referred to henceforth as the YGA strain.

Strain JB flagellates were transferred from FTS to CPLM medium (cysteine, peptone, liver influsion, maltose) with 5 percent serum but without agar (CPLMNA), on which they were maintained for three transfers. Twenty-four-hour cultures (total of 6 liters) from the fourth transfer were centrifuged at 2000 rev/min for 10 minutes at 5°C, and the centrifugate was washed twice with Earle's balanced salt solution containing penicillin and dihydrostreptomycin. The washed centrifugate was suspended in 5 ml of sterile 0.154*M* sodium chloride–0.01*M* sodium citrate and frozen immediately. (Standard sterility tests for the presence of microorganisms other than the trichomonads gave uniformly negative results.) The suspension was homogenized at 0°C under sterile conditions in a Potter-Elvehjem tissue grinder with a small amount of alumina. A microscopic examination of the homogenate revealed a very few intact nuclei. (A series of media, including FTS, which were inoculated with the homogenate remained sterile during 14 days of incubation.)

The total nitrogen of the homogenate was 3.94 mg/ml as determined by Lang's method (*4*). The homogenate was analyzed for nucleic acid according to the modified Schmidt-Thannhauser procedure (*5*), with the use of salmon sperm deoxyribonucleic acid (DNA) and *d*-xylose as standards. The homogenate contained 76 μg of DNA (as DNA) and 780 μg of ribonucleic acid (as pentose) per milliliter.

All experimental and control inoculations involved 6-to-8-week-old mice of the C57 B1/6 strain. The cultures which were to be tested on mice were grown routinely for 48 hours in tubes containing 10 ml of FTS. In experiments I and II, as well as in control experiment B, 0.5-ml aliquots of trichomonad suspensions were inoculated into each tube.

In experiment I, (i) a 48-hour culture of YGA strain maintained for three transfers on CPLMNA was centrifuged, and the centrifugate was washed twice with Earle's balanced salt solution containing penicillin and dihydrostreptomycin. (ii) The final centrifugate was resuspended in 5 ml of 0.137*M* sodium chloride and, upon addition of 1 ml of the JB homogenate, was incubated at 37°C for 8 hours. (iii) Following incubation, 0.5-ml aliquots of the suspension were inoculated into tubes, each containing 10 ml of CPLMNA. The organisms were carried through two transfers on this medium. (iv) A 48-hour culture from the second transfer was treated as in (ii) and (iii) above, except that 1.5 ml of JB homogenate was added to the suspension of trichomonads. (v) After 8 hours' incubation, the suspension was grown on FTS. Mice were inoculated with trichomonad cultures from this medium.

In experiment II, the contents of seven large lesions from experiment I were suspended in FTS containing penicillin and dihydrostreptomycin. Appropriate aliquots of the suspension were inoculated into FTS, which provided the material for injections into mice.

In control experiment A, mice were inoculated with 48-hour cultures of untreated YGA strain. In control experiment B, YGA cells were treated as in steps (i) to (iii) of experiment I, except that 8 μg of crystalline deoxyribonuclease (Sigma Chemical Co.) were added to the suspension containing the parasites and the JB homogenate. After 8 hours' incubation, 0.5-ml aliquots of the suspension were inoculated into FTS. As in experiments I and II, the mice were injected with 48-hour cultures grown on this medium.

All control and experimental lesions were routinely spot checked for sterility. No foreign microorganisms were found on any media, but invariably excellent trichomonad cultures were obtained on FT and FTS.

All experimental data are summarized

Table 1. Effect of treating avirulent *Trichomonas gallinae* with homogenate of virulent strain as evidenced by lesions produced in mice.

Expt.	No. of mice	Treatment of avirulent (YGA) strain	Mean volume of lesions (mm^3)			
			6 days	s*	14 days	s*
I	30	Treated twice with virulent (JB) homogenate	27.82	16.62		
II	16	Cells from lesions of expt. I.	35.64	26.64	46.27	36.59
Control A	16	Untreated	9.28	8.12	10.97	10.01
Control B	21	Treated with JB homogenate and deoxyribonuclease	13.02	10.87	17.02	16.63

*s = sample standard deviation.

in Table 1. The results obtained were compared statistically with the aid of the nonpaired t-test. In all instances the mean volumes of the lesions produced by cells treated with homogenate alone (experiments I and II) were found to be significantly different, on all levels, from the corresponding (6- and 14-day) controls ($P<0.001$). There were, however, no significant differences between controls A and B on the 6th or 14th day after inoculation ($0.1<P<0.2$). Further, no statistically significant differences could be demonstrated between the mean volumes of the 6-day lesions observed in experiments I and II ($0.1<P<0.2$).

The foregoing results suggest strongly a DNA-dependent transformation of the YGA strain, with respect to virulence. It seems probable that virulence is a genetically controlled character among the strains of *T. gallinae*. It must be noted that the mean volume of lesions resulting from inoculations of the transformed YGA strain is very much smaller than the mean volume of lesions observed after inoculation of mice with JB strain. In experiments performed several weeks earlier with the latter strain, the mean volume of 6-day lesions was 158.53 mm^3 ($s = 97.38$).

Two possibilities may be considered in explaining these results. It could be assumed that the conditions for transformation present in the foregoing experiments were far from optimum, and that thus only a relatively small proportion of organisms became transformed. This hypothesis can and will be tested by modification of the conditions under which YGA organisms are exposed to the JB homogenate. On the other hand, we may be dealing with a stepwise transformation. This latter assumption can be proved unequivocally only by the establishment of the homogeneity of the transformed cultures.

It may be of interest to add that recent studies on the mechanisms of pathogenicity of the JB strain in chick cell cultures have not revealed characteristic inclusion bodies, ascribable to the presence of the flagellates. Consequently, if viruses influence the pathogenicity of this strain, they are evidently restricted to the protoplasm of the parasites (*6*).

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24 August 1959

Proton Flux during the Great Aurora of 3–4 September 1959

Abstract. Photoelectric measurements of the Hβ intensity show that it continued to increase after a corona formed, and reached a maximum as the corona broke up into rays, decreasing rapidly to nearly zero within the next 10 minutes. The maximum flux of protons incident on the earth during the aurora, deduced from these measures, was at least 1.4×10^8 auroral protons per square centimeter, per second.

On the night of 3–4 September 1959 an extremely bright aurora was visible throughout Canada and the northern United States. At the Pine Bluff Observatory of the University of Wisconsin, a small telescope designed and ordinarily used for photoelectric measurements of diffuse and planetary nebulae was on this occasion used to measure the Hβ radiation from the aurora, and thereby to determine the flux of protons incident on the earth's upper atmosphere.

The telescope is a 5-inch f/5 achromatic refractor, and the Hβ radiation is isolated by an interference filter, made by Baird-Atomic, Inc., with measured peak wavelength 4864 A and nominal band width 30 A. Light transmitted by this filter passes through a circular diaphragm in the focal plane, which was 3.86 mm in diameter and therefore defined a field of 21.7′ in diameter for all the observations reported here. The light is then measured by a conventional astronomical photoelectric photometer, built around a refrigerated 1P21 photomultiplier. The only strong emission line of either the aurora or a gaseous nebula transmitted by the filter is the Hβ λ4861 line, and the measurements were calibrated into energy units by comparison with measurements made with the same equipment of planetary nebulae having known Hβ fluxes (*1*). This calibration was made indirectly; the aurora was compared with the very bright star α Lyrae on 3–4 September, and the star was in turn compared with the planetaries as part of the regular nebular program on nights before and after the aurora.

On the night of 3–4 September the first auroral measurement was made at 2124 C.S.T.; the aurora then had already been visible for over an hour, growing steadily brighter, and was still in the quiet-arc stage. At this time the sky was also measured at a point 58° south of the zenith, far from the bright part of the aurora, in order to determine the sky correction. The sky light is due to the continuous radiation of all the faint stars included within the area of sky measured, as well as to the faint scattered radiation from the lights of the city of Madison, 15 miles distant, and of the nearer but smaller villages of Mazomanie and Cross Plains. A mean sky correction was subtracted from all the measurements to find the residual intensity due to the aurora alone, but since the true sky brightness undoubtedly varies with position and time, this procedure introduces some error. The maximum measured auroral intensity is over seven times larger than the sky correction, and is therefore quite accurate, but the correction is a larger fraction of the fainter auroral intensities, which are therefore less well determined. The measurements were also corrected slightly for atmospheric extinction according to a coefficient derived from observations on previous nights.

From 2124 C.S.T. on, the Hβ intensity at the zenith increased more or less continuously until it reached a maximum at 2142 C.S.T., 7 minutes after it had first been noted that the quiet arc was beginning to form rays and at the time when a well-marked corona was about 10° south of the zenith. The corona then broke up, and the aurora consisted mostly of bright rays, some changing brightness erratically, while the Hβ flux decreased steadily, reaching a level of 0.2 of the maximum only 10 minutes later. Another sky measurement was taken in the south, and by 2200 C.S.T. there was no detectable Hβ radiation from the zenith, though visually the aurora was still extremely bright, being made up in large part by then of rapidly pulsating rays. Faint Hβ radiation could still be measured 60° north of the zenith until 2210, when observations were stopped, but its brightness was only about 0.1 of the maximum flux, and so this measurement is quite uncertain because of the large sky correction and also because some of the flux may have come from the Vegard-Kaplan (2, 15) band of N_2, which is weakly present in auroras (*2*) and is partially transmitted by the filter. The photoelectric measurements therefore show that the primary proton flux occurs not only during the quiet-arc stage, as Fan and Schulte (*3*) have emphasized, but also in this aurora continued and increased into the beginning of the stage of formation of rays, as Bless and Liller (*4*) also found for the aurora of 9–10 April 1957.

The most significant quantitative measurement was the measured Hβ intensity at the zenith, approximately 1.6×10^{-6} erg/cm² sec received at the earth from a circle 21.7′ in diameter. (For 2 minutes just at the maximum the recording pen, which was unattended, went off scale, but from the slope of the graph before and after this time it is safe to say that the maximum flux was only about 15 percent above full scale.) This observed intensity corresponds to a total emission in Hβ (assumed isotropic) of 6.4×10^{-6} erg/sec cm² column of atmosphere, or of 1.5×10^{9} photon/sec cm² column of atmosphere, and since according to the theory worked out by Chamberlain (*5*) each incident fast proton produces about 11 Hβ photons in the course of being slowed down, the maximum flux incident on the earth's upper atmosphere during the aurora was at least 1.4×10^{8} proton/cm² sec. This figure is a lower limit to the maximum flux, because protons incident with energies below about 100 kev produce less than 11 Hβ photons (*6*). The measured maximum flux is similar to the maximum flux of 1.0×10^{8} proton/cm² sec found by Bless and Liller (*4*) from their measurements of the Hβ intensity during the aurora of 9–10 April 1957 and to the maximum flux of 1.6×10^{8} proton/cm² sec measured by Hunten (*7*) as the upper limit for a number of bright auroras, and so a value of this order of magnitude may be characteristic of all very bright auroras (*8*).

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2 November 1959

Benzimidazole Enhancement of Ion Uptake by Plant Roots

Abstract. Excised barley roots in the presence of benzimidazole accumulate about twice as much potassium in 6 hours as those in a potassium source only. The enhanced rate of uptake is maintained steadily during this time. Sodium and calcium accumulation are similarly augmented but not at identical levels.

In the course of our studies on the physiology of plant roots, the differential effect of certain antibiotic and antimetabolites on growth, water uptake, and ion accumulation have been examined. Several benzazoles, which might be viewed either as purine or indole analogs, were compared in various systems and found to have some activity in repressing root growth and water uptake. Suggestions to the effect that benzimidazole might form complexes with certain metallic ions and thus interfere with their functioning have been postulated by Hillman (*1*) and by McCorquodale and Duncan (*2, 3*). In fact McCorquodale and Duncan (*3*) made the further suggestion that benzimidazole "pumps" ions out of the cell into the external medium, thus causing growth inhibitions due to ion deficiencies. If such is the case, the usual pattern of ion uptake would not prevail. Unexpectedly, however, cation accumulation by barley roots, either excised or attached, was found to be substantially enhanced by certain concentrations of benzimidazole and to a lesser degree by its 5-chloro derivative. Benzotriazole and benzothiazole, which were more active than benzimidazole in repressing growth and water uptake, did not similarly enhance ion accumulation in the ranges tested.

Most of our experiments have been carried out on excised roots from 7-day Atlas-46 barley seedlings grown in mass culture in an aerated medium containing $7.5 \times 10^{-5}M$ $CaSO_4$ and $2.5 \times 10^{-5}M$ $MgSO_4$. The samples of excised roots, 7.5 gm fresh weight in size, were treated with a 200-ml solution containing the cation and antimetabolite at 25°C. The solutions were continuously aerated through sintered glass aerators during the test period, up to 6 hours. Analyses for K^+, Na^+, and Ca^{++} were made by flame photometry in a Beckman model DU spectrophotometer. The amount of cation taken up by the roots was usually determined by difference between the initial and final content of the ambient solution.

In preliminary experiments, excised roots exposed to $1 \times 10^{-3}M$ benzimidazole accumulated about twice as much potassium from unbuffered $1 \times 10^{-3}M$ K_2SO_4 as roots in the same strength of potassium salt alone. The response curve for enhancement of potassium uptake plotted against benzimidazole concentration passes through a peak in the vicinity of $1 \times 10^{-3}M$; at both higher ($3 \times 10^{-3}M$) and lower ($< 1 \times 10^{-4}M$) concentrations the amount accumulated is not significantly different from that accumulated by the untreated roots.

Rate studies showed that the enhanced rate of potassium uptake in the presence of benzimidazole was maintained steadily for at least 6 hours (Fig. 1). In this typical experiment, excised roots in $1 \times 10^{-3}M$ K_2SO_4 accumulated potassium at a steady rate of 30 μg of K per hour, per gram (fresh wt.) after the first hour, whereas with the added presence of $1 \times 10^{-3}M$ benzimidazole, the steady rate was 124 μg of K per hour, per gram (fresh wt.)—almost four times higher. At the termination of the experiment; the benzimidazole-treated roots had accumulated 1.0 mg of K per gram (fresh wt.) while the ambient solution, initially containing 78 μg of K per milliliter, was depleted to 40 μg/ml, whereas in the potassium sulfate alone only 0.387 mg of K per gram (fresh wt.) was accumulated with the ambient solution still containing 63 μg/ml. The effect of benzimidazole, therefore, is to augment the accumulation process.

Enhancement of potassium uptake does not necessarily require the simultaneous presence of benzimidazole and

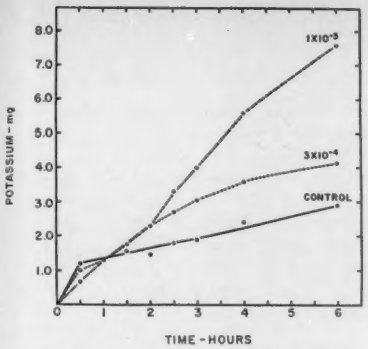

Fig. 1. Rate and extent of potassium uptake by excised barley roots in the presence of various levels of benzimidazole during a 6-hour period (7.5 gm fresh weight of barley roots in 200 ml of $1 \times 10^{-3}M$ K_2SO_4 at 25°C).

potassium salt. Roots pretreated with benzimidazole and then transferred to $1 \times 10^{-3}M$ K_2SO_4 attained a potassium content substantially higher than that of untreated excised roots placed in the potassium source for an equal time (0.68 mg of K per gram [fresh wt.] by the benzimidazole pretreated roots versus 0.32 mg/g [fresh wt.] by the untreated roots; pretreatment and uptake periods were each 3 hours).

The additional increment of potassium entering the roots in the presence of benzimidazole is mobile and becomes distributed through the plant. This was determined in experiments with intact barley seedlings, which, after exposure to $1 \times 10^{-3}M$ benzimidazole and K_2SO_4 for 24 hours, were transferred to potassium-free medium for 1 week to allow transport to the leaves to occur.

The benzimidazole enhancement of uptake is not peculiar to potassium but has been demonstrated also with sodium and calcium, with the use of excised barley roots. The response curves for the different ions do not appear to be identical; in fact, the benzimidazole concentration producing maximum calcium uptake is lower than that for potassium. There also appears to be an enhancement of nitrate uptake, but not of chloride, from their respective potassium salts. Increased potassium uptake has been shown to occur with excised pea roots, but could not be demonstrated with rooted tomato cuttings.

The evidence presently available is compatible with the view that the increased ion uptake induced by benzimidazole is brought about as the result of some enlargement of the specific accumulatory mechanism. The respiratory activity of root tips (Q_{O_2}) is unaffected by benzimidazole at the concentrations enhancing ion uptake. The increased accumulation of potassium is not cyanide-sensitive, and the potassium can be substantially but not completely removed from roots by treatment with excess 0.001*N* HCl for 3 hours. The normal pathways of ion uptake in barley roots generally favor potassium over sodium. The increase in sodium taken up from Na_2SO_4 when benzimidazole is present is not nearly as large as the increase in potassium from K_2SO_4 under similar conditions; thus the relative ease of entry of these two cations is not changed by bezimidazole.

Benzimidazole therefore may increase the number or capacity of the specific carrier sites, perhaps by incorporation in the carrier, or accelerate the rate-limiting, irreversible step at the inner surface of the membrane whereby the ion is split from the carrier, thus increasing the effective capacity of the carrier complex.

In considering such hypotheses, it would be helpful to know the effect of benzimidazole, if any, in the ion accumulatory systems of mammalian tissue, or of microorganisms (*4*).

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11 September 1959

Magnetic Damping of Rotation of the Vanguard I Satellite

Abstract. Explicit integration of integrals of the type basic to comparison of observed and predicted values of the earth's mean total magnetic field reveals an error in the numerical integration recently employed by Raymond H. Wilson, Jr., in making such a comparison for the special case of Vanguard I. Correction of this error destroys the satisfactory agreement he found between the value implied by rotational damping and the theoretical value.

Raymond H. Wilson, Jr., reports (*1*) satisfactory agreement between the mean total magnetic field of the earth, as deduced from the observed decreasing spin rate of satellite 1958β2, and the value of the earth's mean total magnetic field, as calculated from the theory of L. Bauer. The near agreement found by Wilson rests on his evaluation by numerical integration of the integral

$$h = \int_0^{\pi} \frac{dM}{(1 - 0.19 \cos M)^3} \qquad (1)$$

where the constant 0.19 in the integrand is the eccentricity of the orbit followed by satellite 1958β2, and the variable of integration, M, is the mean anomaly of the satellite. This numerical integration is in error, as is shown below. Furthermore, if other elliptic orbits of different eccentricities, e, are considered, each such orbit calls for a separate numerical integration, an obvious disadvantage.

Integrals of the type of Eq. 1 have been explicitly integrated by me in connection with a critical re-examination of the conjecture that the magnetic field of the earth is responsible for such remarkable concentrations of siderites as that within the so-called Farrington circle, a conjecture first subjected to an invalidating numerical test under certain simplifying assumptions some 20 years ago. (*2*).

If we consider the indefinite integral

$$I = \int \frac{dM}{(1 - e \cos M)^3}, \quad 0 \leqq e < 1 \qquad (2)$$

suggested by an obvious generalization of the definite integral (Eq. 1), it is not difficult to verify that, except for the integration constant $I = J/2(1 - e^2)^3$, where J is given by

$$J = \frac{(4e - 3e^3 \cos M - e^3)}{(1 - e \cos M)^2} \sin M - \frac{2 + e^2}{(1 - e^2)^{\frac{1}{2}}} \arcsin \frac{\cos M - e}{1 - e \cos M} \qquad (3)$$

Since for the special case considered by Wilson, the term in Eq. 3 involving $\sin M$ as a factor vanishes at the limits of integration, while e has the value 0.19, it is found that

$$h = \frac{-2.0361}{2(0.9639)^{5/2}} \times \arcsin \frac{\cos M - 0.19}{1 - 0.19 \cos M} \Bigg|_0^{\pi} = 1.11606\pi \qquad (4)$$

a value more than 11 percent in excess of the value $h = 1.0051\pi$ implied by Eq. 15 in Wilson's paper. The correct value of the time mean field according to Bauer's theory is therefore $\overline{H}_B = 0.15767$ gauss and not 0.142 gauss. The discrepancy between this value of $\overline{H}_B$ and the observed value $\overline{H}_O = 0.138$ gauss is almost five times that obtained by adopting the erroneous value $\overline{H}_B = 0.142$ gauss.

In view of the importance of the problem attacked by Wilson, the un-

satisfactory discrepancy between theoretical and observed $\bar{H}$-values here pointed out is an additional argument for acceleration of more precise studies of the sort he enumerates in the concluding paragraph of his interesting report.

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19 October 1959

Abstract. Continued numerical improvement of all parts of my previous report, based on later accumulation and rediscussion of data, has revealed several small random adjustments, including the arithmetical correction discussed by LaPaz. The consequent result remains a satisfactory agreement of the ground-observed geomagnetic dipole field with that deduced from rotational retardation of the Vanguard I satellite.

Had his services been available, an independent computer could probably have caught the arithmetical error in the evaluation of the integral of Eq. 15 of my report (*1*) before it crept into print. Fortunately, however, continued accumulation and discussion of new data on this Vanguard I problem have resulted in several mutually compensatory numerical adjustments, which, when generally accounted, as I shall do below, still preserve a good agreement between the magnetic field deduced from satellite rotational damping and that from previous geomagnetic theory.

When my attention was first called to the arithmetical error (*2*), I found among my earlier notes the closed general solution for the definite integral discussed by LaPaz:

$$I = \frac{(1 + e^2/2)\pi}{(1 - e^2)^{3/2}} \qquad (1)$$

which I overlooked in the final round-up for publication. My derivation of it consisted simply of direct use of formulas 308 and 300 in Peirce's tables (*3*); thus I arrived by a different route at a result equivalent to that of LaPaz.

Even so, my less elegant approach by numerical integration using Simpson's rule with five points, which, when corrected, gives $\bar{H} = 0.1574$ gauss, seems not altogether inappropriate, since, as stated seven lines above it in my report, the denominator of the integral is only a first approximation. The *exact* geocentric distance is

$$r = a\,(1 - e\,\cos\,E) \qquad (2)$$

where E is the eccentric anomaly in Kepler's famous transcendental equation

$$M = E - e\,\sin\,E \qquad (3)$$

so that the approximation shown used only the first-power term in an infinite alternating power series in the eccentricity e. Inclusion of further terms in this series for r (*4*) would render closed integration practically impossible, and such terms should be considered for the level of accuracy discussed by LaPaz. For example, inclusion of the second-power term, so that

$$r = a\left[1 - e\,\cos\,M + \frac{e^2}{2}(1 - 2\,\cos\,2M)\right] \qquad (4)$$

in the integral, would give $\bar{H} = 0.1505$ gauss. With this power series the truncation error of the integral is approximately $3(-e)^n\bar{H}/2(n-1)!$, where n is the order of the first omitted term. Hence, using $n = 3$, a final estimate for the integral, using the coefficient given in the report, would be $\bar{H} = 0.1515$ gauss, having an error of less than 0.1 percent.

However, the relevant uncertainties in the data and other physical assumptions of the report are at least as important as the above purely mathematical discussion. For a properly balanced conclusion it is therefore necessary to report here some significant progress on the physical side of the question since the previous article was published. In general these refinements seem to converge toward equalization of the mean magnetic field deduced from rotational damping with that from other means of measurement.

It was suggested by Richard Andryshak of this Center that, although the maximum geomagnetic inclination of the satellite orbit is about 45°, the mean would be the same as the geographical, namely, 34°, so that the latter value should replace $\pi/4$ everywhere in Eq. 14. Carrying out this correction, one obtains $\bar{H}_H = 0.286$ gauss, $\bar{H}_V = 0.175$ gauss, and $\bar{H}_0 = 0.335$ gauss. Substitution of the last number for 0.356 in Eq. 15 yields $\bar{H} = 0.148$ gauss, using the correction discussed by LaPaz, or $\bar{H} = 0.143$ gauss, using the higher order approximation for that integral.

New data on the satellite and its rotation are continually being accumulated, and the reductions correspondingly revised. The 10-day means of rotational speed, as recorded up to 1 December 1959 by the Tracking Systems Division of this Center, continue to waver about a straight line on a semi-logarithmic grid, as shown in Fig. 1. However, the mean relaxation time deduced from this extended curve is now 230 days, a 10-percent increase over

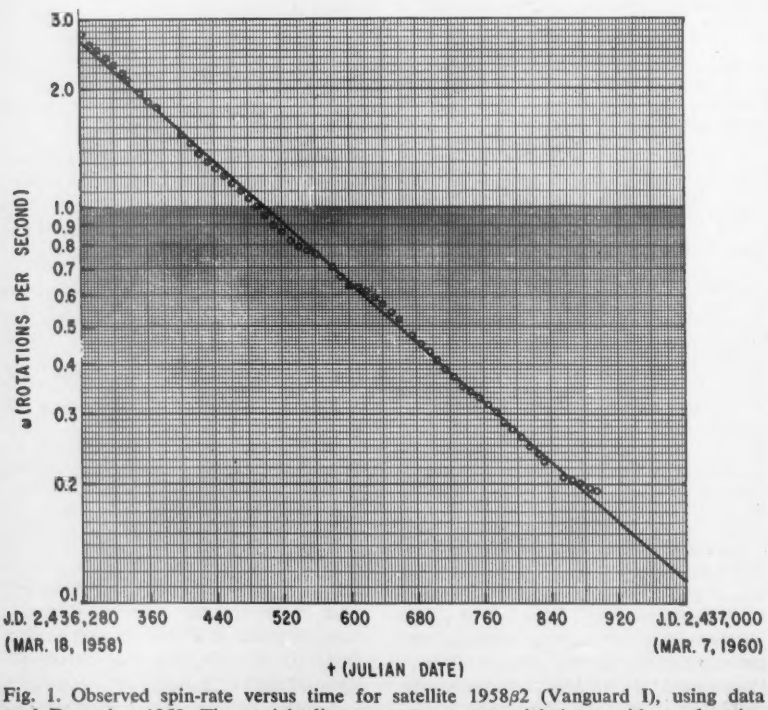

Fig. 1. Observed spin-rate versus time for satellite 1958β2 (Vanguard I), using data to 1 December 1959. The straight line represents exponential decay with a relaxation time of 230 days.

that in the previous report, by including an additional year of observations. That number should replace 210 in Eq. 1 of my report, and consequently 5.03 should replace 5.51 in Eqs. 1a and 3 there. This change would imply a 5-percent decrease in the deduced field, provided that the spin-axis of the satellite has remained fixed in space. However, the spin-axis might be expected theoretically to drift slowly toward parallelism with the magnetic field, thus decreasing the magnetic component normal to the axis and the damping factor resulting therefrom. Such axis drift would produce just such a secular lengthening of the relaxation time, which should be omitted for the present purpose if new orientation data were also available to confirm it. However, without such orientation data we shall need several more months of rotation speed data as a basis for decision about the quantitative importance of spin-axis drift.

Since the steel battery cans have lately been found experimentally to have an effective permeability of only about 2 (almost nonmagnetic) for a field perpendicular to their geometric axes; it seems necessary to abandon the previous assumption that the body-orientation of the spin-axis remained, as at orbital injection, parallel to the geometric axes of the batteries. It is in agreement with mechanical theory, recently confirmed by direct evidence for the analogous case (*5*) of Vanguard II, to expect that the position of the original body-axis, about which the moment of inertia is smaller, would be unstable. Hence, within a short time after its detachment from the launching rocket, the satellite would have slipped to rotation about a stable axis near its original equator, since about this axis the moment of inertia would be a maximum for the satellite. Note that this change of body-orientation of the axis does not necessarily imply any change in its space-orientation. The new corresponding moment of inertia was measured before launching as 69,203 gm-cm^2, a 2-percent increase which would correspond to a 1-percent increase of the magnetic field. When this number replaces 67,885 as an additional revision of Eq. 3 of the report, the observed total damping coefficient in that equation and the last member of Eq. 7 becomes 0.00348 gm-cm^2 sec. This change would correspond to a 4-percent decrease in the derived field.

Direct measurements of pertinent physical properties of the satellite materials are being carried out at the National Bureau of Standards, the resistivities under supervision of James Thomas, and magnetic permeabilities under Irvin Cooter. Resulting data for the spherical aluminum shell are changed little: $1/\sigma = 4633$ electromagnetic units (emu) at the measured (*6*) mean temperature 45°C for the satellite 80 percent of the time in sunlight and a mean thermal coefficient 0.004 per degree centigrade. For the seven steel battery cans they found $1/\sigma = 13{,}600$ emu (the previously printed value should have read 78,000 instead of 78), and $\mu = 42$. That latter value is the measured effective initial magnetic permeability of the cylindrical can (which ranged from 65 along its axis down to 2 for a field normal to that line), for the mean field component parallel to its geometrical axis. Owing to the above-discussed 90° shift of body-axis orientation, the revised damping couple on all the cylindrical shells should now be computed using only Eq. 6 of the previous report. The result for the additional couples is 0.39 that due to the spherical shell, so that 1.39 should replace 2, and 2.78 should replace 4 in the second and third members, respectively, of Eq. 7. This change corresponds to a 13-percent increase in H.

Using the revised numbers and data in Eqs. 2 and 7, the satellite damping constant $K = 312{,}000$ sec-gauss$^2 = 3.61$ day-gauss^2 by Eq. 8. Solving Eq. 7 gives the mean field normal to the spin-axis as $\bar{H}_\perp = 0.125$ gauss to replace 0.115 in Eq. 9. This new value is then substituted in Eq. 17, together with the revisions of Eq. 14 discussed above which change Eq. 16 to read: $\bar{H}_V/\bar{H}_H = 175/286 = 0.6119$. The resulting new Eq. 18 for the mean total field deduced from rotational damping is $\bar{H} = 0.144$ gauss, and the agreement with either the approximate solution 0.148 or the more exact 0.143 of Eq. 15 is still satisfactory.

This revised calculation is based entirely on directly measured data, except for spin-axis orientation. Errors of 2 percent in the measured conductivity or about 3 percent in the magnetic permeability would each lead to a 1-percent error in the derived magnetic field.

Owing to the temperature coefficient of conductivity, known to be 0.004 per degree centigrade, an error of only + 5° in the assumed mean temperature 45°C would also cause an error of + 1 percent in the calculated field. For this reason, space "weathering" by pelting meteorites and radiation, by deteriorating the satellite's temperature-controlling silicone coating, could cause the possible secular increase in the rotational relaxation time noted above.

Indeed, the wavelike variations of slope of the spin-rate curve, which correspond to variations in relaxation time between about 210 and 280 days, that is, between 9 percent below and 22 percent above the mean, may thus be fully explained by respective temperature variations of 22° below and 55° above the assumed mean. Observed temperatures (*6*) indicate a possibility of such a range. The minimum slope of the rotation curve occurred around December in both 1958 and 1959, a season when the highest satellite temperatures would be expected (*7*), owing to the annual maximum of both solar and terrestrial heating intensity. The solar maximum then is due to the earth's passing perihelion, and to the extreme solstitial solar declination causing the satellite to be in sunlight 100 percent of the time over a period of 3 weeks. The annual maximum of terrestrial heating at that season would be due to the Southern Hemisphere's being at its hottest, and the Northern, with its dominant land area, at its whitest (*8*).

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14 December 1959

Induction of Ovulation in Immature Hypophysectomized Rats

Abstract. Immature rats given minute doses of highly purified pituitary gonadotropins (follicle-stimulating hormone and luteinizing hormone) 7 to 100 days after hypophysectomy ovulated and formed corpora lutea. Neither hormone alone was effective. Luteinizing hormone repaired in part the atrophied theca interna and interstitial tissue, and follicle-stimulating hormone stimulated the development of the granulosa cells.

Until the recent availability of highly purified pituitary gonadotropins (follicle-stimulating hormone and luteinizing hormone) (*1*), it was impossible to (i) identify with clarity the real physiological actions of these hormones, (ii) induce ovulation, and (iii) produce corpora lutea in hypophysectomized rats. Up to that time, *all* of the pituitary gonadotropins tested were either too

scant in amount for assessment of their physiological activity in more than one or two laboratories or badly contaminated one with the other, or they contained rather large amounts of the other pituitary factors (for example, ACTH, growth hormone, somatotropic hormone, and thyroid-stimulating hormone). It is now possible to obtain follicle-stimulating hormone and luteinizing hormone which are quite free of noticeable contaminating effects of other pituitary tropins, as determined by biological methods. In this report preliminary announcement is made of the physiological effects of these gonadotropins.

Since it is well known that residual gonadotropins remain in the system for 10 or more hours after hypophysectomy (*2*), it was essential to obtain a series of animal controls as an indisputable base line. Preliminary experiments indicated that animals hypophysectomized at least 4 to 7 days prior to the tests proved satisfactory, but it seemed more desirable to utilize rats that had been hypophysectomized at least 14 to 100 days prior to the experiment. These rats proved extremely sensitive to the contaminating effects of the gonadotropic preparations previously used and provided the best criteria for the evaluation of the gonadotropins herein described. The rats were of the Sprague-Dawley strain, obtained from the Charles River Breeding Laboratories, and were hypophysectomized by the parapharyngeal approach. Injections of hormone vehicle and hormones were made subcutaneously twice daily for 4 days, necropsies were performed 14 hours after the last injection, and the sella turcica of each animal was inspected to determine the completeness of pituitary removal. Each group contained at least five to seven animals.

The tabulated data in the control series reveals that the saline vehicle for the gonadotropins is without effect on the entire reproductive tract. Furthermore, the atrophy of the sex tract continues from at least 7 to 100 days after the removal of the pituitary body (see Table 1).

Histologic examination of the serially sectioned ovaries and attached oviducts of the gonadotropin-treated rats reveals that low doses of either follicle-stimulating hormone or luteinizing hormone alone (< 250 μg) do not induce ovulation under the conditions of these experiments. Throughout the entire series of experiments, irrespective of the interval between hypophysectomy and the 96-hour period of gonadotropin administration, it was observed (i) that the action of follicle-stimulating hormone is primarily one of stimulation of the granulosa cells of the Graafian follicles and secondarily the partial functional stimulation of ovarian interstitial tissue, and (ii) that luteinizing hormone acts preferentially by stimulating the theca interna and ovarian interstitial tissue, a fact well in accord with the reports by Hisaw (*3*), Greep (*4*), Fevold (*5*), and their colleagues.

Observations from the current experiments further indicate that larger doses of follicle-stimulating hormone (> 250 μg over the 4-day period) readily transform the theca cells that surround the enlarged ovarian follicles into theca lutein cells, and seemingly stimulate the interstitial tissue to produce very large amounts of estrogen. A number of rats given large amounts of either follicle-stimulating hormone or luteinizing hormone alone had numerous ovarian follicular cysts, fragmented ova, and partially stimulated but degenerating follicles and, as evidenced by large uteri, an abnormally high release of estrogen.

Ovulation and formation of corpora lutea occurred in all groups (7 to 100 days after hypophysectomy) given at least 250 μg of follicle-stimulating hormone and 100 μg of luteinizing hormone. These same amounts, injected at separate sites over the 4-day period, produced maximal stimulation of uterine growth (evident in both wet and dry weights and in percentage of uterine nitrogen) and vaginal cornification, both being effected by the release of ovarian estrogen(s) by the action of follicle-stimulating hormone and luteinizing hormone on the ovaries.

These experiments (*6*) clearly suggest that there are two distinct gonadotropins acting upon the ovaries: follicle-stimulating hormone acting on the granulosa cells, luteinizing hormone acting on the theca interna and interstitial tissue, and a combination of the two acting to produce estrogen secretion, ovulation, and corpus luteum formation. Exogenous levels above the physiologic dosages —that is, those above 250 μg—produce aberrant ovarian conditions, chief among which are cystic follicles and prodigious amounts of estrogen secretion.

Table 1. Influence of highly purified follicle-stimulating hormone (F.S.H.) and luteinizing hormone (L.H.) in female rats at different periods after hypophysectomy. Additional abbreviations: V.C., vaginal cornification; Lg. fol., large follicles; Med. fol., medium follicles; Cyst. fol., cystic follicles; Thec. lut., theca lutein; C.L., corpora lutea of ovulation; I.T., interstitial tissue (+1 to +4, minimum to maximum stimulation); Pre-ov. fol., preovulatory follicles; Sev., several; Lg. cyst. fol., large cystic follicles.

Period (days*)	Total dose‡ (μg)		Ovarian		Uterine		V.C.
	F.S.H.	L.H.	Wts. (mg %)†	Histology	Wts. (mg %)†	Histology	
			Control series, given 0.2 ml. of saline daily				
7	0	0	25.0	Atrophied	31.0	Atrophied	–
14	0	0	14.0	Atrophied	21.0	Atrophied	–
21	0	0	14.0	Atrophied	18.0	Atrophied	–
50	0	0	8.3	Atrophied	14.3	Atrophied	–
100	0	0	6.2	Atrophied	14.6	Atrophied	–
			Experimental series				
7	250	0	47.0	Lg. fol. + 2 I.T.	110.0	+4	+
7	250+2000§	0	72.2	Cyst. fol., thec. lut. + 3 I.T.	113.0	+4	+
7	250+1000§	1000	76.0	Lg. fol., C.L., + 3 I.T.	142.0	+4	+
14	100	0	18.0	Med. and lg. fol.	23.0	Atrophied	–
14	250	0	24.0	Lg. fol. + 2 I.T.	40.0	+2	Initial
14	500	0	33.0	Pre.-ov. and cyst. fol. + 3 I.T.	68.0	+4	+
21	100	0	14.0	Atrophied, few med. fol. + 1 I.T.	19.0	Atrophied	–
21	250	0	24.0	Sev. lg. fol. + 2 I.T.	53.2	+2	+
21	0	100	15.0	Atrophied	18.0	Atrophied	–
21	0	250	19.0	Few healthy med. fol. + 2 I.T.	19.0	Atrophied	–
21	0	500	50.0	Pre-ov. fol., sev. with ovum and corona free, + 3 I.T.	88.4	+2	+
21	100	100	19.0	Atrophied, sev. med. fol. + 2 I.T.	28.0	+1	–
21	250	100	45.0	13 hr. C.L., 24 hr. C.L., lg. cyst. fol. + 4 I.T.	98.0	+4	+
21	250	250	49.0	C.L., pre-ov. fol. + 4 I.T.	124.0	+4	+
50	250	0	11.5	Few med. fol. + 2 I.T.	33.7	+2	+
50	0	250	13.8	Few med. fol. + 2 I.T.	20.0	+1	+
50	0	500	19.4	Sev. lg. fol. + 3 I.T.	44.0	+3	Initial
50	250	250	20.3	C.L., lg. fol. + 3 I.T.	57.4	+4	+
100	250	0	13.5	Sev. med. fol., several lg. fol., + 2 I.T.	34.1	+1	+
100	0	250	12.1	Sev. med. fol. + 2 I.T.	22.5	+1	?–
100	0	500	18.0	Many med. fol. + 3 I.T.	61.1	+4	+
100	250	250	17.4	Many lg. fol., C.L., + 4 I.T.	84.6	+4	+

* After hypophysectomy. † By mg % is meant organ wt. divided by body wt., with the quotient multiplied by 100. ‡ In all cases except those marked §, total dose was administered over a period of 4 days in two subdivided doses daily. § Smaller dose was administered in 4 days, and the larger dose was administered on the 4th day.

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References and Notes

1. The follicle-stimulating hormone was made available through a grant from the Endocrine Study Section, U.S. Public Health Service, National Institutes of Health. The luteinizing hormone was provided as a gift by the Armour Laboratories, Kankakee, Ill. Both preparations were made from sheep pituitaries.
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26 August 1959

New Technique for the Collection and Isolation of Airborne Microorganisms

Abstract. Pure cultures of airborne microorganisms are obtained by simple electrostatic attraction to small glass and plastic cylinders which are rolled over the surface of nutrient agar medium. Little equipment is required, and the necessary materials are inexpensive. Satisfactory qualitative sampling is possible under varying conditions of relative humidity.

The difficulty and expense involved in sampling microorganisms in the airborne state by conventional means has made the development of a simple inexpensive method desirable. Such a method has been developed by taking advantage of simple electrostatics. A small plastic rod, electrostatically charged by rubbing, is exposed to the air for a short time and then rolled over the surface of nutrient agar.

Table 1. Data from qualitative sampling for *Staphylococcus pyogenes* in a hospital. Volume of air sampled by liquid impinger, 25 lit. Period of exposure of charged glass rod, 30 seconds. Ratios, number of qualitative "positive" samples compared to number of samples taken. Temperature 75°F; relative humidity 56 percent.

Area sampled	Ratios for	
	Impinger technique*	Charged rod technique
Ward 1	2/4	6/8
Ward 2	4/4	4/8
Ward 3	2/4	1/4
Fracture room	2/4	5/8
Recovery room	2/4	6/8
Operating room	1/4	1/4
Linen room	0/2	2/4
Stores room	1/2	2/4
Physiotherapy	2/2	1/4
Laboratory	1/4	1/8
Bathroom	2/2	1/4
Main corridor	2/2	0/4
Total	21/38	30/68

* Impinger collections were assessed by the "drop plate" dilution method (*4*). One colony per plate (1/8 ml neat dilution) normally equals 3.2 organisms per liter (flow rate for Shipe impinger, 12.5 lit. per minute).

The materials (Fig. 1) required for simple electrostatic sampling are easily obtained at very low cost. In our experience 2-inch lengths of ¼-inch extruded plastic rod (dimpled at the ends) or tubing (inside diameter, ⅛ inch) or 7.5-mm glass capillary tubing have proved most satisfactory. In the laboratory, the rod or tube can be held for charging and exposure by any holder such as a hemostat, gut clamp, or pinch-type clothespin. A suitable rolling clip can be made by bending a length of No. 16 baling wire. For charging the rods, 2-inch squares of folded cotton cloth or gauze or short-pile fur are all that is required.

For routine field use a simple collection kit has been designed. This consists of a plastic tube mounted on a shaft to provide a handle and permit rolling; a charging sleeve; and a compartmented container for different media. These items are sealed within a package to keep the charging materials dry and the entire kit sterile.

The laboratory technique consists of grasping a dry, sterile rod or tube at one end with the clamp; with firm, wrap-around finger pressure, rubbing the rod five or six times with the charging material; holding the rod for the desired length of time (5 seconds to 2 minutes) in the atmosphere to be investigated; grasping the rod by means of the wire clip and rolling it back and forth over the flat smooth surface of the nutrient agar (preferably dried previously for 1 hour).

Relatively large numbers of organisms can be rolled onto the agar surface. With care in rolling, an even distribution of isolated colonies can be obtained. If it is anticipated that larger numbers of organisms will be collected, the rod is shaken in a small volume of diluent and the organisms are washed off the rod; dilution assessment by any of various methods follows.

This method of collecting and plating-out airborne microorganisms has been successful under varying conditions of temperature and relative humidity. Although electrostatic charges soon dissipate from glass at relative humidities above 70 percent, charges on plastics such as styrene, cellulose acetate butyrate, and acrylics provide sufficient attraction for successful collection at relative humidities ranging from 15 to 95 percent.

Collections of airborne organisms have been made in many atmospheres —in animal rooms, laboratories, vestibules, motor vehicles, elevators, and aerosol chambers (*1*), within dynamic aerosol equipment (*2*), and out-of-doors.

Under controlled conditions of temperature and humidity (temperature, 70°F; relative humidity, 53 percent), collections of washed cells of *Serratia marcescens* have been made from dilute, dynamic aerosols by means of positively charged styrene rods. From aerosols containing 84.5, 12.1, and 1.5 organisms per liter, respectively, as determined by the liquid impinger method (flow rate, 16 lit. per minute), satisfactory samples (20 to 1 colonies per rod) were collected; the ratios of the number of "positive" samples to the number of samples taken were 12/12, 9/12, and 2/12, respectively, for these three aerosols.

Table 1 shows recoveries under uncontrolled conditions in a hospital. Included for comparison are results obtained by a standard air-sampling method.

In experimental use of the method of sampling airborne microorganisms by an electrostatically charged rod, the findings are as follows. (i) The amount of rubbing seems to have very little effect on collection, provided the whole surface has been charged. (ii) The number of aerosolized microbiological particles collected depends upon the concentration of these particles in the atmosphere and the effective electrostatic charge on the sampler during the sampling period. (iii) Firm rolling, with gentle pressure, six or eight times across the agar surface in the petri dish will assure an even distribution of isolated colonies, and nearly all the organisms collected will be removed from the rod.

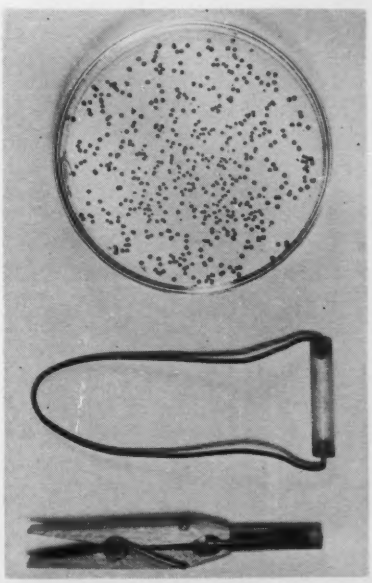

Fig. 1. Materials required for electrostatic rod sampling and a rolled plate showing isolated colonies of *Serratia marcescens*.

This method of sampling provides a means of qualitatively assessing the microbiological material suspended in the air in any situation. It should be especially useful in hospitals and in the field of agriculture (*3*).

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4 December 1959

Incorporation of Tritiated Thymidine into Nuclei of Shoot Apical Meristems

Abstract. Tritiated thymidine enters readily into certain excised plant parts and into small aquatic plants. Attempts to introduce the radioisotope into shoot tips of seed plants via the roots have not proved satisfactory. The label readily enters the shoot if applied directly to immature leaves of a bud after the application of a wetting agent.

The general availability of tritiated thymidine has resulted in its use on a variety of organisms. Its use is designed to elucidate specific biochemical pathways of deoxyribonucleic acid synthesis which do not yield themselves readily to chemical analysis. Methods of application have varied considerably, as follows: small animals have been injected (*1*) or fed (*2*) with success; excised portions of tobacco pith incorporate the label (*3*); roots readily absorb thymidine (*4*); algae and aquatic cryptogams absorb the radioisotope with particular facility (*5*). Attempts to introduce and bring about incorporation of H^3-thymidine into the shoot systems of intact seed plants have not always been successful.

In a preliminary experiment, young (6 to 7 in. high) intact plants and excised shoots of *Chenopodium album* were placed in half-strength Hoagland's solution and H^3-thymidine (10 μc/ml). Shoot-tip samples were fixed at 3- and 5-day intervals. The material was fixed in FPA, processed in butyl alcohol, embedded in paraffin, and sectioned at 7 μ; the sections were then covered with autoradiographic stripping film AR.10 (Kodak). After exposure for 14 days the film was developed in DK19b (Kodak); the sections were stained with Harris' hematoxylin, and the slide was made permanent by mounting the sections and superposed film in Harleco resin. Examination of the autoradiographs did not reveal the presence of the label in the shoot apical regions, but nuclei of the root tips were labeled. Although longer periods of exposure to thymidine were not tried, the results of the preliminary tests indicated that the isotope becomes fixed in the meristematic root tips but does not move readily in the transpiration stream, as does P^{32} for example. The results indicated that other modes of movement and transport must be involved.

The application of H^3-thymidine "dropwise" to the terminal bud [preceded by the application of a drop of the wetting agent Tween-20 (0.1 percent)] resulted in foliar penetration and subsequent movement of the label to all young leaves, to the shoot apex, and to subjacent stem regions. One drop (approximately 0.05 ml of a solution containing 10 μc of the label per milliliter) was applied each day for 3 days. Whether movement, after initial penetration, was primarily through the phloem was not determined. To test the possible rapid movement in the phloem, the label was applied to fully expanded photosynthesizing leaves. After 3 days very little, if any, of the isotope could be detected in the autoradiographs of meristematic regions. It is possible that the thymidine molecule did not penetrate the mature outer walls of epidermal cells. The radioisotope was introduced also by injecting it into the stem a short distance below the shoot apex. This procedure resulted in the general distribution of the label into young leaves and the shoot apex. This method, however, does not appear to be as effective as that of tip application.

As may be noted in Fig. 1*A*, labeled nuclei are apparent (they appear totally black at this magnification) in the leaf to the left, in the developing pith, and to a lesser extent in the leaf at the right. Presumably the label was initially in direct contact with the leaf to the left. In Fig. 1*B* it may be noted that nuclei of cells of the shoot apex near the tip (on the right), as well as those in subjacent regions, have reduced silver grains over them. The two centers of activity on the upper right flank are well within the region of presumed mitotic inactivity, as described by some workers (*6*). It would not appear that these cells are inactive in deoxyribonucleic acid synthesis. If endomitotic reduplication and metabolic turnover are ruled out, the incorporation of thymidine into deoxyribonucleic acid is indicative of subsequent mitotic activity.

The utilization of H^3-thymidine, in conjunction with the use of P^{32} (*7*), should provide reliable information relative to sites of mitotic activity and aid in the elucidation of the growth of shoot apical meristems (*8*).

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8. This work was supported by the National Science Foundation (research grant G-6130). The labeled thymidine was supplied by Schwarz Laboratories.

25 September 1959

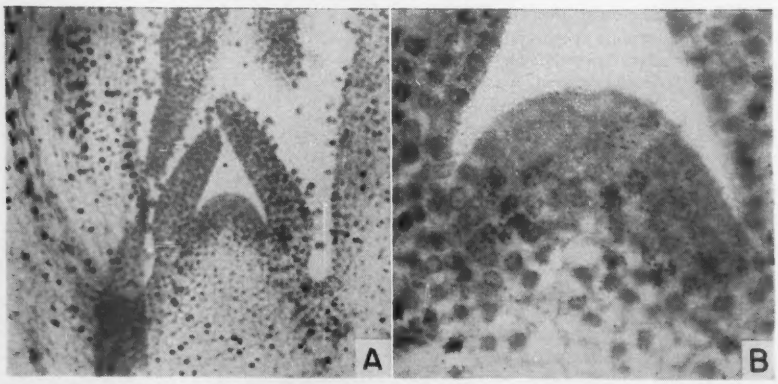

Fig. 1. (*A*) Shoot apex and young leaves of a bud of *Chenopodium album* treated with H^3-thymidine. Nuclei which incorporated the label are dark in appearance (× 125). (*B*) Details, shoot apex of same specimen (× 580).

Meetings

History of Science

The 9th International Congress of the History of Science convened in Barcelona, 1 September 1959, bringing together scholars from many nations—Arabia, Austria, Belgium, Canada, Czechoslovakia, Denmark, France, Germany, Great Britain, Holland, Israel, Italy, Japan, Poland, Russia, Spain, Sweden, Switzerland, Turkey, and the United States—both to share their ideas and to establish those personal contacts which are so important in bringing about an exchange of information. The opening meeting was held in an impressive assembly room in the city hall and was followed by a visit to the Disputación Provincial, directly across the square.

The president and secretary of the congress were, respectively, José Millás-Vallicrosa and Juan Vernet of the University of Barcelona. The university was the seat of the congress, and the academic papers were presented in its lecture rooms. The papers were divided into long ones, which had been requested, and short ones which had been offered. There were six of the former and innumerable of the latter. Printed copies of the longer papers and printed résumés of the shorter ones were distributed to the members as they completed their registration.

The first of the long papers was read on the afternoon of the opening day by Millás-Vallicrosa, who discussed the relations between oriental and occidental science. Three more of the long papers were presented on the succeeding three mornings. They dealt with the development of science in medieval Europe, especially in the 14th and 15th centuries; the relationship between American and European science; and the development of classical medicine and biology from medieval to modern times. The congress moved to Madrid on 5 September, and the remaining two invited papers were delivered there. The subject of one was cartography. The other was concerned with recent studies on the history of mathematics and physics in Europe from the 16th century to the 18th century. Although these papers bore little relation to each other, they all pointed either to the interrelation of the different sciences in their historical development or to the interaction between the science of one nation or one culture and that of another. In one way or an other, each talk stressed the continuity of scientific development.

The 10-minute papers covered a very wide field and were grouped into sessions dealing with the history of technology and applied science; the history of chemistry and pharmacy; the

history of mathematics, physics, and astronomy; and the history of geography and geology. There was, in addition, a catch-all session for papers not clearly within the subject area of one of the other divisions. The very large number of these shorter papers bears witness to the world-wide growth of interest in the history of science and to the increase in the number of individuals trained as specialists in this field. However, having so many papers scheduled for these sessions made it necessary to divide some of the groups at the last minute. Thus, for example, it was impossible for the physicists to hear the papers of their colleagues in astronomy, and vice versa. This was unfortunate because, as those at the congress so well knew, the history of science is not a history of the development of the separate sciences but must be based on the concurrent development of these sciences and their contributions to each other.

A number of papers corrected or amplified previous assumptions by historians and bore witness to the high caliber of the scholarship represented and to the fact that the history of science is being rewritten in the light of recent research. The discussions which followed the talks were lively and significant.

The genial, hospitable Spanish hosts provided numerous opportunities for sight-seeing and social gatherings. In Barcelona there was a visit to the naval museum, a reception at the *Spanish Village*, a visit to the Academy of Medicine and Surgery and to the Biblioteca Central across the courtyard, and an excursion from Barcelona to Masnou and the museum of pharmacology at the Laboratorios del Norte de España. In Madrid, there were opportunities to see the naval museum, and the Prada, which many of the participants in the Congress revisited several times.

The final meeting was held 7 September at the Escorial near Madrid. A magnificent luncheon was served at a hotel on the hill overlooking the monastery. There the George Sarton medal was awarded by Henry Guerlac, president of the History of Science Society, to Alexandre Koyré, eminent scholar of 16th- and 17th-century physics and astronomy, who divides his time between the Sorbonne and the Institute for Advanced Study at Princeton. At this luncheon it was announced that the next International Congress of the History of Science will be held in the United States, at Cornell University, in 1962. The invitation had been issued and accepted at a meeting in Barcelona of the general assembly of the Division of the History of Science of the International Union of the History and Philosophy of Science. The congresses are a responsibility of the division, although the actual task of organizing and run-

ning them is left to the host nations. The division has also set up international committees to study the teaching of the history of science, to catalog scientific instruments of historical importance, and to examine or maintain bibliographical and documentary services. The United States adheres to the Union through the National Academy of Sciences–National Research Council, under whose auspices the United States National Committee for the International Union of the History and Philosophy of Science has been established. The other division of the Union is that of the Philosophy of Science.

During the course of the congress there were two meetings of that especially distinguished body known as the Académie Internationale d'Histoire des Sciences. At the second meeting Henry Guerlac was elected president, to succeed Vasco Ronchi of Italy.

The United States delegates to the congress were Henry Guerlac (chairman), Marshall Clagett, I. Bernard Cohen, C. Doris Hellman, Harry Woolf (alternate), and Duane Roller (alternate).

C. DORIS HELLMAN
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Forthcoming Events

March

2–4. Low and Medium Energy Nuclear Physics, colloquium, Grenoble, France. (F. Netter, C.E.N., Saclay, BP. No. 2, Gif-sur-Yvette. Seine et Oise, France.)

3–5. American Acad. of Forensic Sciences, Chicago, Ill. (W. J. R. Camp, AAFS, 1853 W. Polk St., Chicago 12.)

3–5. Association of Clinical Scientists, Albany, N.Y. (R. P. MacFate, 323 Northwood Rd., Riverside, Ill.)

4–6. National Wildlife Federation, Dallas, Tex. (C. H. Callison, 232 Carroll St., NW, Washington 12.)

6–13. American Otorhinologic Soc. for Plastic Surgery, Miami Beach, Fla. (J. G. Gilbert, 75 Barberry Lane, Roslyn Heights, N.Y.)

7–9. Wildlife Management Inst., Dallas, Tex. (C. R. Gutermuth, 709 Wire Bldg., Washington 5.)

7–11. American Soc. of Civil Engineers, New Orleans, La. (E. S. Kirkpatrick, ASCE, 33 W. 39 St., New York 18.)

10. Recent Developments in Poultry Nutrition (Assoc. of Vitamin Chemists), Chicago, Ill. (J. T. Sime, Director of Research, Evaporated Milk Assoc., 228 N. La Salle St., Chicago 1.)

10–11. Institute of the Aeronautical Sciences–Flight Propulsion, Cleveland, Ohio. (S. P. Johnston, 2 E. 64 St., New York 21.)

13–14. American Otological Soc., Miami Beach, Fla. (L. R. Boies, University Hospital, Minneapolis 14.)

14–16. American Railway Engineering Assoc., annual conv., Chicago, Ill. (N. D. Howard, AREA, 59 E. Van Buren St., Chicago 5.)

14–17. Positive Health of Older People, forum, Miami Beach, Fla. (A. Mallach, National Health Council, 1790 Broadway, New York 19.)

14–18. National Assoc. of Corrosion Engineers, 16th annual, Dallas, Tex. (W. A. Mapler, NACE, 18263 W. McNichols Rd., Detroit 19, Mich.)

15–16. American Broncho-Esophangological Assoc., Miami Beach, Fla. (F. J. Putney, 1712 Locust St., Philadelphia 3.)

15–21. Nondestructive Testing, 3rd intern. conf., Tokyo and Osaka, Japan. (S. Ishizaka, Scientific Attaché, Embassy of Japan, 2514 Massachusetts Ave., NW, Washington 8.)

16–18. Genetics Soc. of Canada, 5th annual, Vancouver, B.C. (Miss K. Cole, Dept. of Biology and Botany, Univ. of British Columbia, Vancouver 8.)

17. Congress for Pharmacists, 2nd annual, Jamaica, N.Y. (Congress for Pharmacists, Public Relations Office, St. John's Univ., Jamaica 32.)

17–19. American Radium Soc., conf., San Juan, Puerto Rico. (ARS, 635 East Union, Pasadena, Calif.)

17–19. Blood Platelets, intern. symp. (by invitation only), Detroit, Mich. (Miss S. A. Johnson, Henry Ford Hospital, Detroit 2.)

17–20. International Assoc. for Dental Research, Chicago, Ill. (D. Y. Burrill, Northwestern Univ. Dental School, 311 E. Chicago Ave., Chicago 11.)

18–19. American Laryngological Assoc., Miami Beach, Fla. (L. Richards, Massachusetts Inst. of Technology, Cambridge.)

20–23. American Assoc. of Dental Schools, Chicago, Ill. (R. Sullen, 840 N. Lake Shore Drive, Chicago 11.)

20–26. American Cong. on Surveying and Mapping, Washington, D.C. (C. E. Palmer, American Soc. of Photogrammetry, 1515 Massachusetts Ave., NW, Washington 5.)

20–26. American Soc. of Photogrammetry, Washington, D.C. (C. E. Palmer, ASP, 1515 Massachusetts Ave., NW, Washington 5.)

21–24. American Acad. of General Practice, 12th annual, Philadelphia, Pa. (AAGP, Volker Blvd. at Brookside, Kansas City 12, Mo.)

21–24. Institute of Radio Engineers, natl. conv., New York, N.Y. (L. G. Cumming, IRE, 1 E. 79 St., New York 21.)

22–24. High-Polymer Physics, 20th, Detroit, Mich. (T. L. Smith, American Physical Soc., Stanford Research Inst., Menlo Park, Calif.)

23–25. National Council on Alcoholism, annual, New York, N.Y. (M. Ross, American Psychiatric Assoc., 1700 18 St., NW, Washington 9.)

23–25. Optical Spectrometric Measurements of High Temperatures, symp., Chicago, Ill. (F. Brech, Laboratories for Applied Science, Univ. of Chicago, 6220 S. Drexel Ave., Chicago 37.)

24–25. Human Factors in Electronics, 1st annual symp. (IRE), New York, N.Y. (J. E. Karlin, Bell Telephone Laboratories, Murray Hill, N.J.)

24–26. American Assoc. for the History

of Medicine, Charleston, S.C. (J. B. Blake, c/o Smithsonian Institution, Washington 25.)

24–26. Aviation Education, 4th natl. conf., Denver, Colo. (W. Kinkley, Superintendent of Schools, Aurora, Colo.)

26–27. American Psychosomatic Soc., 17th annual, Montreal, Canada. (E. D. Wittkower, APS, 265 Nassau Rd., Roosevelt, N.Y.)

28–31. Exploitation of Natural Animal Populations, symp., Durham, England. (E. D. Le Cren, British Ecological Soc., The Ferry House, Ambleside, Westmorland, England.)

29–31. American Power Conf., 22nd annual, Chicago, Ill. (R. A. Budenholzer, Mechanical Engineering Dept., Illinois Inst. of Technology, 3300 Federal St., Chicago 16.)

29–2. National Science Teachers Assoc., 8th annual conv., Kansas City, Mo. (Miss M. R. Broom, NSTA, National Education Assoc., 1201 16 St., NW, Washington 4.)

30–31. Adrenergic Mechanisms, Ciba Foundation symp. (by invitation only), London, England. (G. E. W. Wolstenholme, Ciba Foundation, 41 Portland Pl., London, W.1, England.)

31–1. Continuous Culture of Microorganisms, symp., London, England. (R. Elsworth, c/o Ministry of Supply, Microbiological Research Establishment, Porton, Salisbury, Wilts., England.)

31–2. American Gastroenterological Assoc., New Orleans, La. (W. Volwiler, Dept. of Medicine, Univ. of Washington, Seattle.)

April

1–3. American Soc. of Internal Medicine, San Francisco, Calif. (R. L. Richards, 350 Post St., San Francisco 8.)

1–3. American Soc. for the Study of Sterility, Cincinnati, Ohio (H. H. Thomas, 920 S. 19 St., Birmingham 5, Ala.)

1–4. Bahamas Medical Conf., Nassau. (B. L. Frank, P.O. Box 4037, Fort Lauderdale, Fla.)

2. Paleontological Research Institution, Ithaca, N.Y. (Miss R. S. Harris, 126 Kelvin Pl., Ithaca.)

2–6. American College of Obstetrics and Gynecologists, Cincinnati, Ohio. (D. F. Richardson, 79 W. Monroe St., Chicago 3, Ill.)

3–6. American Surgical Assoc., White Sulphur Springs, W.Va. (W. A. Altemeier, Cincinnati General Hospital, Cincinnati, Ohio.)

3–7. International Anesthesia Research Soc., Washington, D.C. (A. W. Friend, E. 107 St. and Park Lane, Cleveland 6, Ohio.)

3–8. Nuclear Cong., New York, N.Y. (P. Lange, Engineers Joint Council, 29 W. 39 St., New York.)

4–6. American Inst. of Electrical Engineers, Houston, Tex. (N. S. Hibsham, AIEE, 145 N. High St., Columbus 15, Ohio.)

4–6. American Inst. of Mining, Metallurgical and Petroleum Engineers (43rd Natl. Open Hearth Steel Conf. and Blast Furnace, Coke Oven and Raw Materials Conf.), Chicago, Ill. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18.)

(See issue of 15 January for comprehensive list)

New Products

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Neither Science *nor the writer assumes responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to the manufacturer. Include the department number in your inquiry.*

■ RECORDING PYROMETER measures brightness temperature at 0.65μ of small incandescent samples in the range 1300° to 3000°C. Accuracy is said to be ±20°C. The instrument consists of an optical system with objective lens, beam splitter, monocnromatic filter, and eyepiece. The eyepiece is used for alignment and focusing. Seventy percent of the light is deflected by the beam splitter to a phototube. Time constant is limited only by the recorder or indicator used. A calibration curve relates output voltage to temperature. Focusing range is 40 to 70 in. At 50 in. the pyrometer measures the average temperature of an area ⅜ in. in diameter. (Avco Corporation, Dept. Sci332, 201 Lowell St., Wilmington, Mass.)

■ DIGITAL MILLIVOLTMETER is a portable instrument weighing 23 lb. and measuring 9¾ by 10-5/16 by 16-5/32 in. Ranges are 1, 10, and 100 mv full scale. Accuracy is said to be ±0.1 percent. The self-contained instrument includes instrument power, standard cell, ratiometer, bridge balance, millivoltmeter, and voltage-level and end-point offset controls. (Technical Industries Corp., Dept. Sci337, 39 North Fair Oaks, Pasadena, Calif.)

■ MAGNETRON PULSE MODULATOR is capable of powering small magnetrons requiring inputs up to 10 kw peak at a duty cycle up to 0.002. Pulse widths from 0.1 to 2 μsec can be supplied. Pulse voltage, average magnetron current, and magnetron filament current are metered. (Bomac Laboratories, Inc., Dept. Sci339, 1 Salem Rd., Beverly, Mass.)

■ PLATINUM RESISTANCE THERMOMETER covers the range −100° to +500°F. Resistance is 470 ohm at 32°F, and the coefficient is 1 ohm/F°. The sensitive element, measuring 0.156 in. in diameter by 0.281 in. long, is potted in a stainless-steel case. Calibration accuracies of ±0.25, ±0.5, and ±1 percent are available. (Minco Products, Inc., Dept Sci340, 740 Washington Ave., North, Minneapolis 1, Minn.)

■ VIBRATION TESTING SYSTEM is a random and sine-wave testing system for the range 5 to 10,000 cy/sec. No impedance changing or manual power-factor correction is required over this range. Peak random force is 2500 lb and sine-wave vector force is 1500 lb when used with the manufacturer's

model A-174 shaker. Power generator, field and degaussing supply, cycling oscillator, servo system, and stop-start controls are housed in a single console with the shaker external. (Ling-Altec Electronics, Inc., Dept. Sci343, Culver City, Calif.)

■ NULL DETECTOR has input impedance of 40,000 ohm and will provide high sensitivity with source resistances up to 100 kohm. Circuitry is designed to provide maximum sensitivity at the null point and saturation on large signals. Sensitivities are 0.2 μv/mm up to 20 kohm source resistance, 0.3 μv/mm from 20 to 50 kohm, 0.5 μv/mm from 50 to 100 kohm. Sensitivity may be varied over a 1 to 1000 range. Period varies from less than 2 sec at 1 kohm to 4 sec at 100 kohm. Zero shift is less than 0.5 div/hr after 1 hr of warm-up. The guard circuit connects to the shield of a two-conductor input cable. (Leeds and Northrup Co., Dept Sci345, 4907 Stenton Ave., Philadelphia 44, Pa.)

■ CLOTTING TIMER operation is based on photoelectric nephelometry. The change of intensity of scattered light extending over the entire clotting reaction is automatically recorded. To determine prothrombin time, thermostatted thromboplastin contained in a microtube is placed in the instrument. The sample is blown into the tube and the recorder is started. The number of divisions between start and end point gives prothrombin time directly. The instrument's optical unit and recorder are separate, permitting use of the latter for other purposes. (Photovolt Corp., Dept. Sci352, 95 Madison Ave., New York 16, N.Y.)

■ REGULATED POWER SUPPLIES for heavy-duty applications are designed to handle input voltage up to 15 kv single-phase or three-phase, 25 to 60 cy/sec, and to furnish output current to 100,000 amp, single-phase, two-phase, three-phase, or d-c. Systems are designed to meet customer specifications. (Heavy-Duty Electric Co., Dept. Sci354, Milwaukee, Wis.)

■ TEMPERATURE MONITOR simultaneously monitors up to 100 points and sounds an alarm when any of the points reaches the temperature indicated on its control dial. The audible alarm may be turned off manually while an identifying light remains on as long as the temperature remains off normal. Actual temperature at any point may be determined by rotating the appropriate set-point dial until the indicating light flashes on. Over-all accuracy is ±3°F. The system is built up of the required number of 10-unit panels. (Fischer & Porter Co., Dept. Sci357, 303 Jacksonville Rd., Hatboro, Pa.)

■ BATTERY PACKS are potted for shock resistance up to 2000 grav. The packs consist of rechargeable nickel-cadmium battery cells. By using any number of cells, the pack can be custom formed to fill what is often considered dead space and to provide any voltage or current capacity required. (Gulton Industries, Inc., Dept. Sci339, 212 Durham Ave., Metuchen, N.J.)

■ SPRAYED-FILM HEATING ELEMENTS have a total thickness of 0.011 to 0.015 in. including base insulation 0.005 in. and top insulation and abrasion protection 0.001 to 0.005 in. The insulating coating normally used provides a dielectric strength of 650 volts. Heating coatings can be applied directly to the part or to detachable components. By appropriate masking, any desired arrangement of serious-parallel circuits can be had. (Electrofilm Inc., Dept. Sci358, 7116 Laurel Canyon Blvd., North Hollywood, Calif.)

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National Bureau of Standards, Washington, D.C.

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Box 25, SCIENCE

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Cytogeneticist, Electronmicroscopist, Ph.D. Experienced in specialized cytological methods, teaching, research. Microbiology, botany background. Numerous publications. Box 16, SCIENCE. X

(a) **Parasitologist**, Ph.D. from leading university, 7 years of teaching experience; desires biology, zoology teaching or parasitology research appointment. (b) **Biochemist**, M.S. degree, 4 years of clinical experience, available for medical supervising or research position. (c) **Organic Chemist**, Ph.D. with extensive experience as group leader in compound synthesis for pharmaceuticals; interested in pharmaceutical research and administration appointment. S2-1 Medical Bureau, Inc., Science Division, Burneice Larson, President, 900 North Michigan Avenue, Chicago. X

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Anatomy Department, Dalhousie University, Halifax, Nova Scotia. Applications are invited for two positions at the rank of **Assistant Professor** in the Department of Anatomy. Experience in the teaching of gross anatomy is essential and a willingness to undertake some teaching in neuroanatomy, histology, or embryology desirable. The successful candidates will be expected to participate in the active research program of the department, for which good facilities are available. Applicants with a medical degree will be preferred although those with an honors degree in medical science or biology will receive special consideration. The minimum salary for a medical graduate will be $6000. The salary will depend upon qualifications and experience. Application should be sent to Professor R. L. deC. H. Saunders at the above address. 3/4; 4/1; 5/6; 6/3

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For further information write to Dean Albert D. Graves, Los Angeles State College, 5151 State College Drive, Los Angeles 32, Calif. X

Biologist, Ph.D., to teach either cytogenetics, botanical sciences, or mammalian physiology in a Catholic university. Rank and salary open. Box 22, SCIENCE. 2/5, 12

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(a) **Director, Clinical Research;** M.D. experienced in clinical pharmaceutical research for midwestern division, prominent concern; minimum $15,000; large university city. (b) **Biochemist;** Ph.D. to direct division, prefer protein experience, administrative ability; rapidly growing pharmaceutical concern, extensive research program, several affiliated; to $14,000; East. (c) **Virologist;** Ph.D. experienced tissue culture; university-affiliated research institute; to $11,000; West Coast. (d) **Biochemist;** M.S., Ph.D. to head section, busy laboratory, 300-bed general hospital; $8000 up; midwestern metropolitan area. (e) **Biochemist;** B.S., M.S.; new, modern laboratory, fully approved 200-bed general hospital, to $7200; residential city near noted eastern university center. Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

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Prospective applicants should write for further information to Prof. H. Kleerekoper, Chairman, Department of Biology, Hamilton College, McMaster University, Hamilton, Ontario, Canada. Application forms both for scholarships and graduate study are obtainable from the Dean of Graduate Studies and must be returned to him normally by **1 March 1960,** accompanied by university transcript and letters of recommendation from two professors. 2/5, 12

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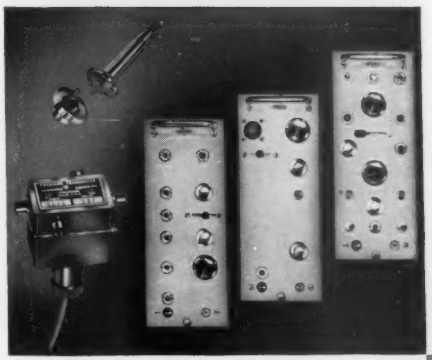

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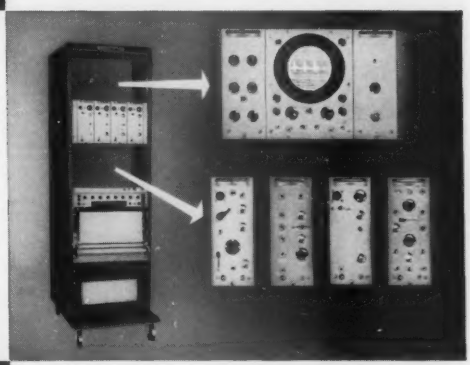

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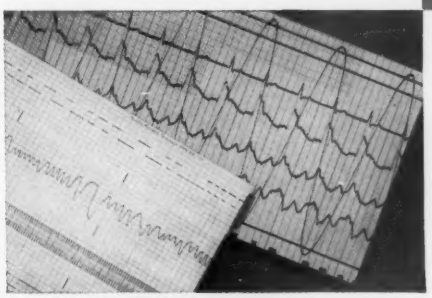

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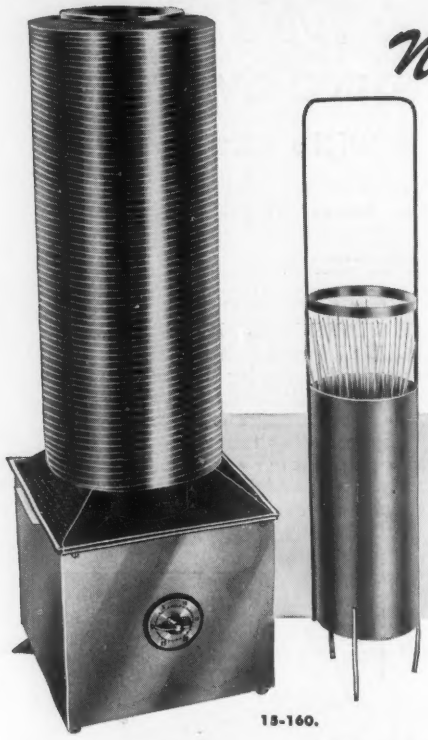

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